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CIVIL ENGINEERING

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MAR 1 1941

ECORATIVE ARCHED VIADUCT LEADS UP FROM NEW YORK'S HARLEM RIVER DRIVE TO TUNNEL AND THENCE TO GEORGE WASHINGTON BRIDGE
View from Washington Bridge Looking Southwest. See Article on Page 154

Volume 11 *Number 3*

MARCH 1941

RAYMOND SOIL INVESTIGATIONS AND TEST BORINGS....

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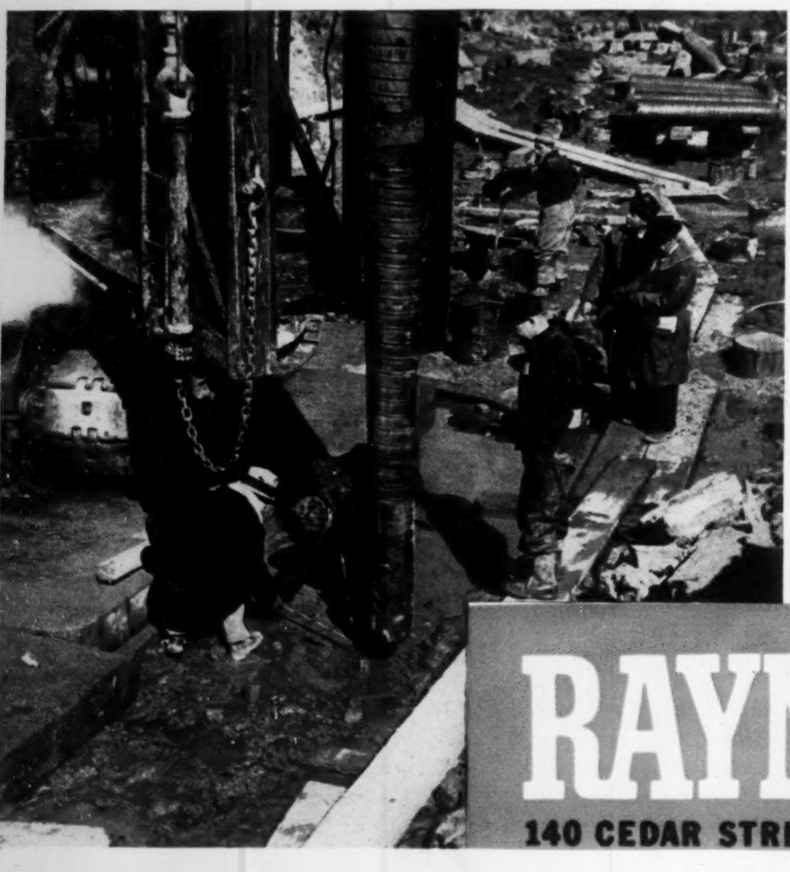
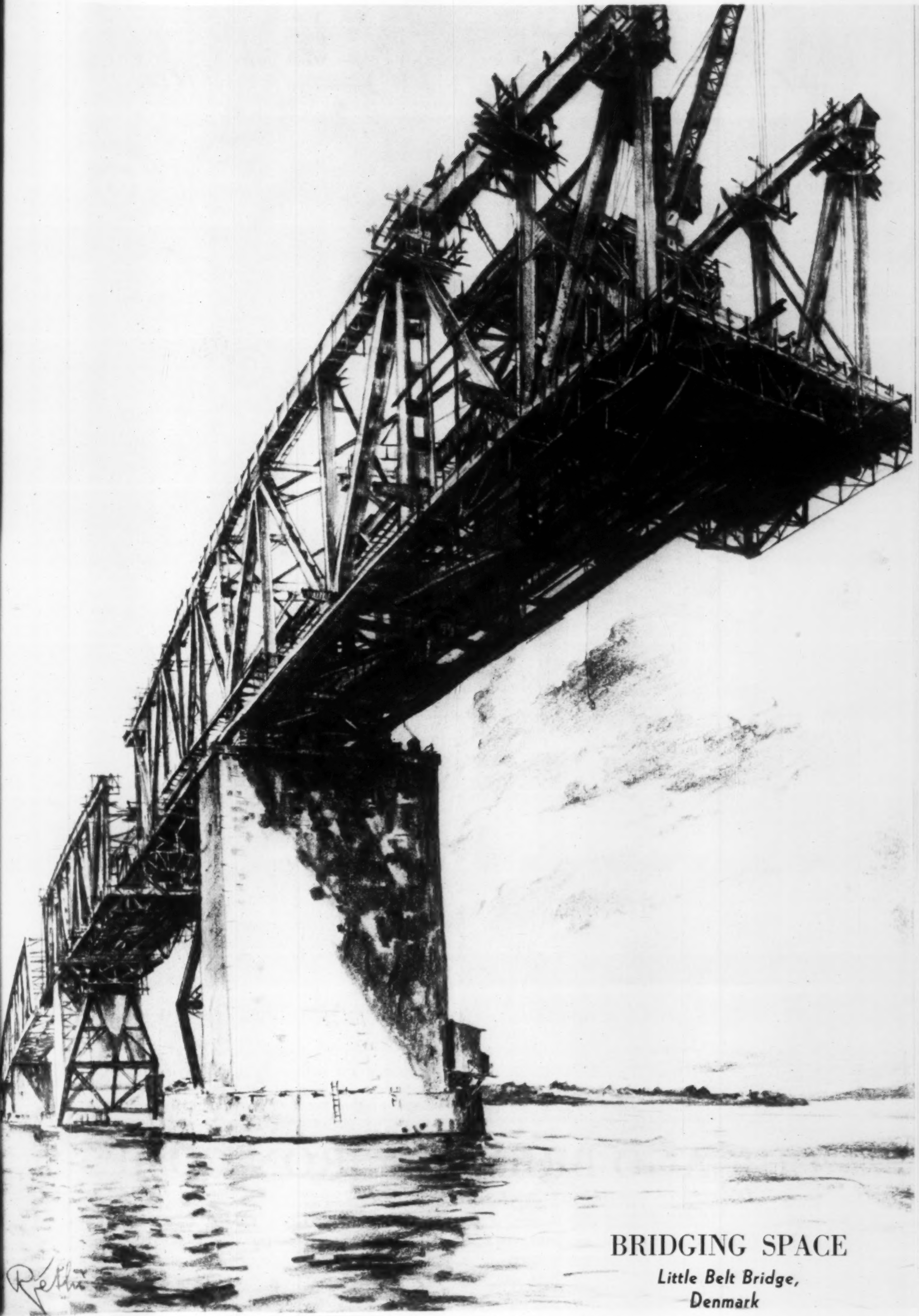
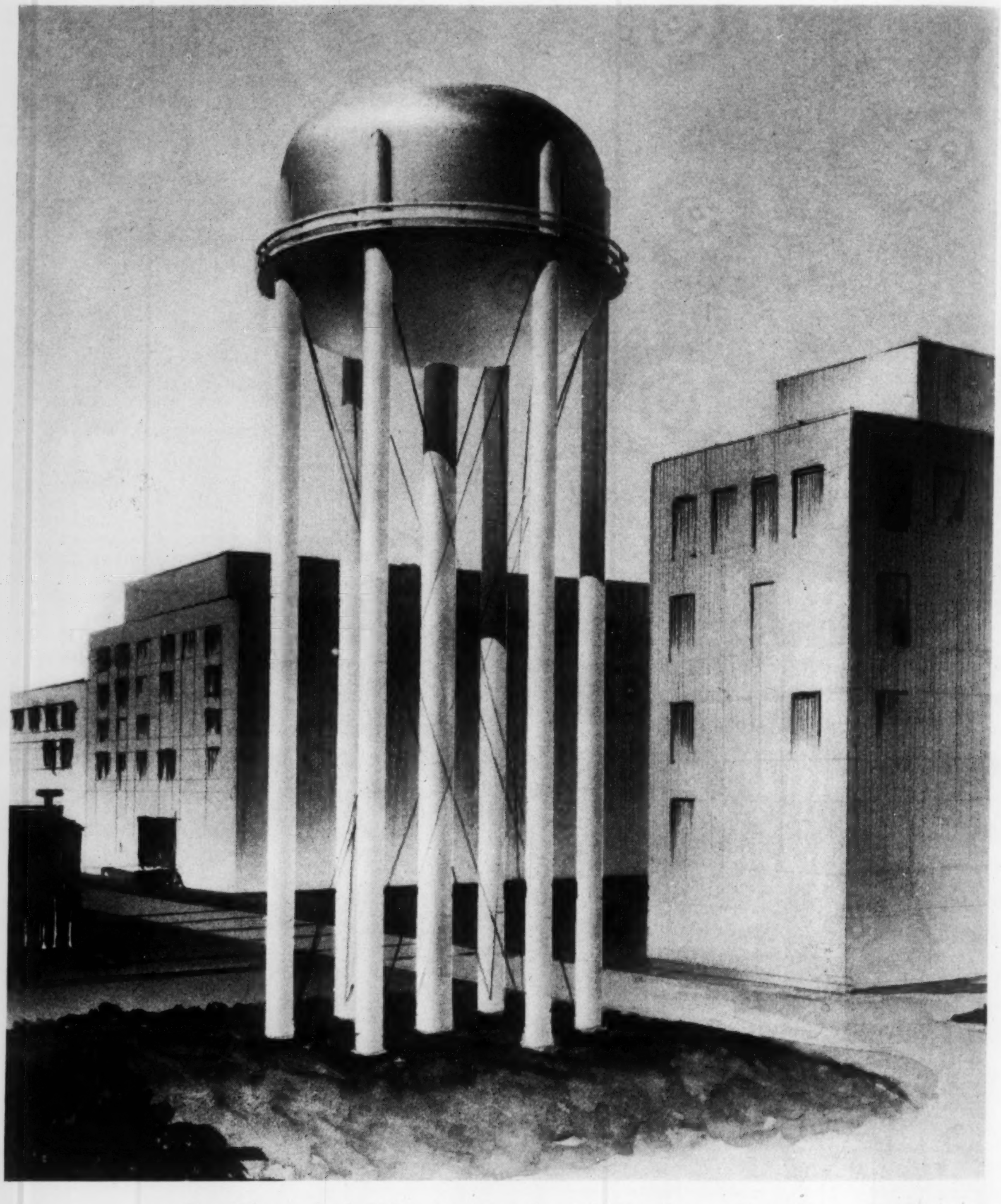




BRIDGING SPACE

Little Belt Bridge, Denmark



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Among Our Writers

Edward S. Bres (Tulane U., B.E., C.E.) recently appointed Zone Engineer in the Office of the Constructing Quartermaster, Zone IV, at Atlanta, is a member of the firm of Scott and Bres, contracting engineers of New Orleans. He is a past-president of the Reserve Officers Association of the U.S. and a Director of the Society.

E. P. Lock, Jr. (U.S.M.A., 1918; U.S.A.C. and G.S.S., 1938) is on duty with the staff of the Engineer School, U.S.A., at Fort Belvoir. His previous assignments have included Columbia River Surveys, Department Tactics, the Calvary School, and command of the 9th Engineers.

Fred C. Dunham located and built much of the Olympia-Nisqually section of the Pacific Highway during his earlier work with the Washington State Highway Department. He was engineer on construction of the State Capitol grounds at Olympia, and since August 1940 has been engaged on betterment surveys for the Pacific Highway near Fort Lewis.

Carlo G. Flebus (Tech. U. of Milan, Doc.Ing.) has seen service in Europe, Africa, and South America. In this country since 1932, he has been engaged in special studies for the City of N.Y. From 1936 to 1938 he was consulting engineer for the Italian Government on the construction of various military plants.

L. M. Davis (Cornell, C.E., 1923) had early experience for $3^{1}/_{2}$ years as engineer of hydraulics with the Niagara Falls Power Co. In 1930, after 2 years of similar work with the Aluminum Co. of America, he took up his present work in hydraulic research for the Pennsylvania Water and Power Co.

E. L. Durkee (Worcester P.I., 1919) since graduation has worked on structural and bridge erection for McClintic-Marshall and Bethlehem Steel Cos. in India, Pennsylvania, New Jersey, New York, South Carolina, Panama, and Louisiana. Now he is resident engineer on the new Rainbow Bridge that will replace the Honeymoon Bridge destroyed by ice at Niagara Falls.

Harold M. Lewis (Williams, 1909; R.P.I., 1912) has been active in the city and regional planning field for the past 20 years. Since 1921 he has been in charge of the technical work of regional planning for greater New York. He has also served as consultant to the National Resources Planning Board and is on the faculty of the Graduate Division for Training in Public Service at New York U.

Joseph D. Lewin (Tech. U's, Karlsruhe, Berlin; École du Génie Civil, Paris) has worked on industrial and hydroelectric developments in Europe and on arch-dam and power-plant designs for the Phoenix Eng. Corp. He has been with the U.S.E.D. in Boston, and has held his present position with Board of Water Supply, City of N.Y., since April 1940. He is also acting as secretary of the Society's Committee on Civilian Protection.

E. L. Tarwater was engaged in laboratory and field research for the then Bureau of Public Roads 1921–1926. For 5 years he was resident engineer on National Park highway and bridge construction, and for the last 2 years has directed inspection work on the Washington Airport and construction work related to the Mount Vernon Memorial Highway.

J. M. Robertson (U. of Ill., 1938; U. of Iowa, M.S., 1940) is now holder of the J. Waldo Smith Fellowship which is this year devoted to the study of air entrainment in pipe flow. **Hunter Rouse** (M.I.T., 1929) spent $2^{1}/_{2}$ years studying laboratory technique in Europe, then returned for 2 more years at M.I.T., $2^{1}/_{2}$ years at Columbia, and $3^{1}/_{2}$ years with the S.C.S. Lab. at Calif. Inst. of Tech. He has held his present position at the State U. of Iowa since 1939.

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1852

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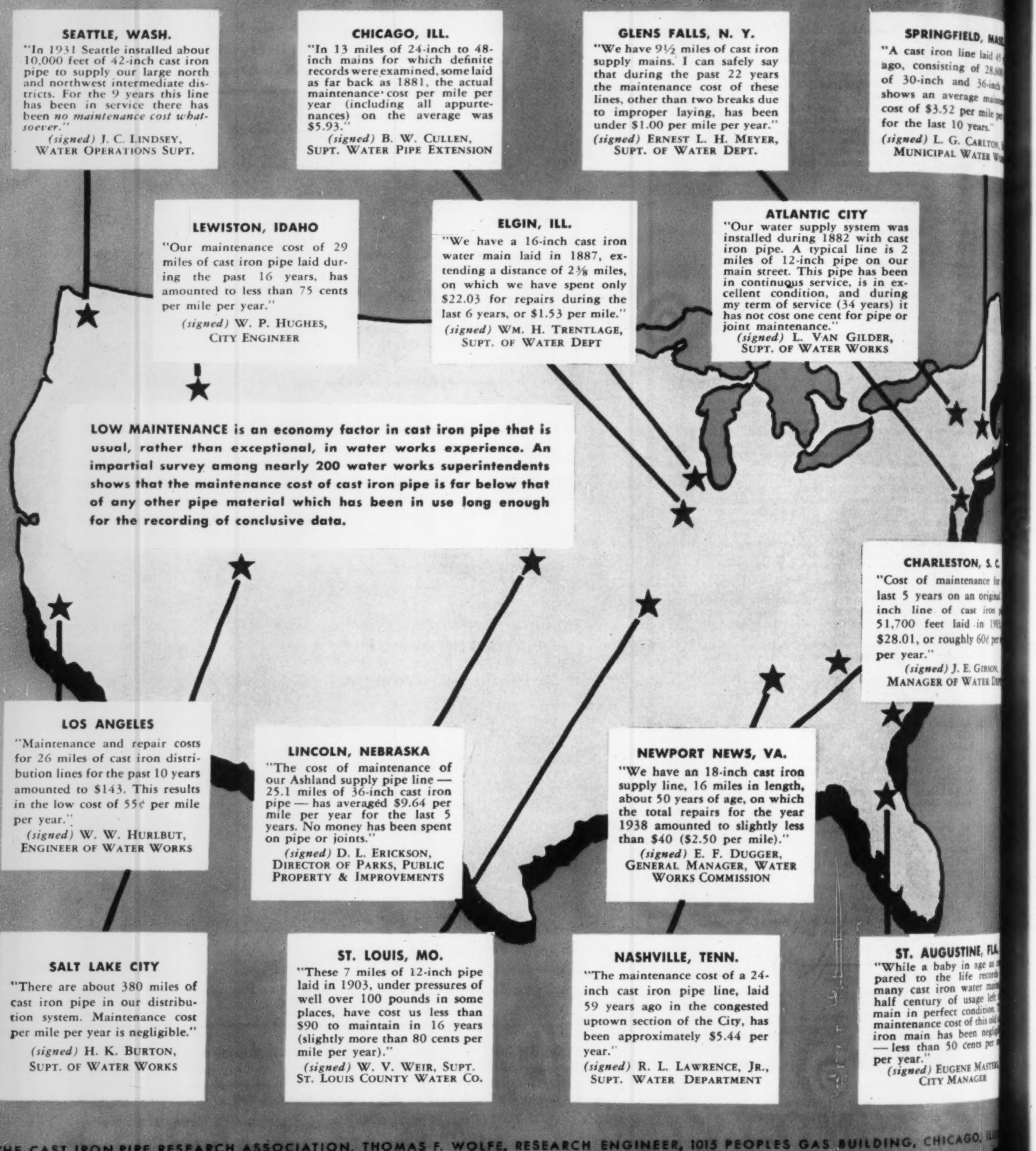
Report on Maintenance Costs



SEATTLE, WASH.

"In 1931 Seattle installed about 10,000 feet of 42-inch cast iron pipe to supply our large north and northwest intermediate districts. For the 9 years this line has been in service there has been *no maintenance cost whatsoever.*"

(signed) J. C. LINDSEY,
WATER OPERATIONS SUPT.

CHICAGO, ILL.

"In 13 miles of 24-inch to 48-inch mains for which definite records were examined, some laid as far back as 1881, the actual maintenance cost per mile per year (including all appurtenances) on the average was $5.93."

(signed) B. W. CULLEN,
SUPT. WATER PIPE EXTENSION

GLENS FALLS, N. Y.

"We have 9½ miles of cast iron supply mains. I can safely say that during the past 22 years the maintenance cost of these lines, other than two breaks due to improper laying, has been under $1.00 per mile per year."

(signed) ERNEST L. H. MEYER,
SUPT. OF WATER DEPT.

SPRINGFIELD, MAS

"A cast iron line laid 45
ago, consisting of 28,60
of 30-inch and 36-inch
shows an average mainte
cost of $3.52 per mile pe
for the last 10 years."

(signed) L. G. CARLTON,
MUNICIPAL WATER WO

LEWISTON, IDAHO

"Our maintenance cost of 29 miles of cast iron pipe laid during the past 16 years, has amounted to less than 75 cents per mile per year."

(signed) W. P. HUGHES,
CITY ENGINEER

ELGIN, ILL.

"We have a 16-inch cast iron water main laid in 1887, extending a distance of 2⅜ miles, on which we have spent only $22.03 for repairs during the last 6 years, or $1.53 per mile."

(signed) WM. H. TRENTLAGE,
SUPT. OF WATER DEPT

ATLANTIC CITY

"Our water supply system was installed during 1882 with cast iron pipe. A typical line is 2 miles of 12-inch pipe on our main street. This pipe has been in continuous service, is in excellent condition, and during my term of service (34 years) it has not cost one cent for pipe or joint maintenance."

(signed) L. VAN GILDER,
SUPT. OF WATER WORKS

LOW MAINTENANCE is an economy factor in cast iron pipe that is usual, rather than exceptional, in water works experience. An impartial survey among nearly 200 water works superintendents shows that the maintenance cost of cast iron pipe is far below that of any other pipe material which has been in use long enough for the recording of conclusive data.

CHARLESTON, S. C

"Cost of maintenance for
last 5 years on an original
inch line of cast iron
51,700 feet laid in 190
$28.01, or roughly 60¢ per
per year."

(signed) J. E. GIBSON,
MANAGER OF WATER DE

LOS ANGELES

"Maintenance and repair costs for 26 miles of cast iron distribution lines for the past 10 years amounted to $143. This results in the low cost of 55¢ per mile per year."

(signed) W. W. HURLBUT,
ENGINEER OF WATER WORKS

LINCOLN, NEBRASKA

"The cost of maintenance of our Ashland supply pipe line — 25.1 miles of 36-inch cast iron pipe — has averaged $9.64 per mile per year for the last 5 years. No money has been spent on pipe or joints."

(signed) D. L. ERICKSON,
DIRECTOR OF PARKS, PUBLIC
PROPERTY & IMPROVEMENTS

NEWPORT NEWS, VA.

"We have an 18-inch cast iron supply line, 16 miles in length, about 50 years of age, on which the total repairs for the year 1938 amounted to slightly less than $40 ($2.50 per mile)."

(signed) E. F. DUGGER,
GENERAL MANAGER, WATER
WORKS COMMISSION

SALT LAKE CITY

"There are about 380 miles of cast iron pipe in our distribution system. Maintenance cost per mile per year is negligible."

(signed) H. K. BURTON,
SUPT. OF WATER WORKS

ST. LOUIS, MO.

"These 7 miles of 12-inch pipe laid in 1903, under pressures of well over 100 pounds in some places, have cost us less than $90 to maintain in 16 years (slightly more than 80 cents per mile per year)."

(signed) W. V. WEIR, SUPT.
ST. LOUIS COUNTY WATER CO.

NASHVILLE, TENN.

"The maintenance cost of a 24-inch cast iron pipe line, laid 59 years ago in the congested uptown section of the City, has been approximately $5.44 per year."

(signed) R. L. LAWRENCE, JR.,
SUPT. WATER DEPARTMENT

ST. AUGUSTINE, FLA

"While a baby in age as c
pared to the life records
many cast iron water mai
half century of usage left
main in perfect condition.
maintenance cost of this old
iron main has been neglig
— less than 50 cents per
per year."

(signed) EUGENE MASTERS
CITY MANAGER

THE CAST IRON PIPE RESEARCH ASSOCIATION, THOMAS F. WOLFE, RESEARCH ENGINEER, 1015 PEOPLES GAS BUILDING, CHICAGO, ILL

CAST IRON PIP

PUBLIC TAX SAVER NO. 1

Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

The Defense Challenge

From Addresses Before the University of Cincinnati Student Chapter and Alabama Section

By Edward S. Bres, M. Am. Soc. C.E.

Colonel, Corps of Engineers, Reserve; Zone Engineer in the Office of the Constructing Quartermaster, Zone IV

SEVERAL months ago our country was aghast at the realization that in spite of the magnitude of our industries and the super strides they had made, we would be unable to manufacture sufficient materials, ammunition, and supplies to equip, in less than a year's time, the first augmentation of our Army of one million men. It was unbelievable.

More unbelievable was the fact that when five semimotorized triangular divisions were ordered into the field in September 1939, in connection with the largest maneuvers ever undertaken, seven months were required to secure sufficient motor equipment even for these 55,000 men. True, the specifications called for motor vehicles not in all respects of commercial type; however, who could have believed this delay possible in our efficient motor industry, which manufactures several million units yearly!

A Crisis at Hand.~We are face to face with a great national emergency—a serious social, political, and economic crisis. To meet and overcome this crisis a vast program of National Preparedness for Defense has been instituted. Traditionally it has been the policy of our national government, after a crisis has passed, to ignore entirely the need for preparedness to meet emergencies that may manifest themselves in the future. In the face of this policy to ignore the future, when an emergency such as the present one appears, our task for preparedness assumes the proportions of an overload burden. I submit that this task and burden falls primarily on the engineers.

Today and at least for the next five years, we engineers are faced with the industrial development and procurement required for a standing army exceeding twenty times, at least, the size of the five divisions that we were unable to equip in less than seven months' time. During maneuvers the food supply, alone, for a mobilization of 50,000 to 100,000 men is a daily problem that can admit of no failures or sudden changes. During the maneuvers of the past summer, for instance, a force of 75,000 men required 150,000 eggs for breakfast. There could be no change in the menu set up for several months in advance, for just what would the Quartermaster do if he found himself with 150,000 eggs left over from one day? Or where would he procure them if plans miscarried or were not efficiently organized?

Other Items of Supply.~Similar problems are encountered with gasoline, oils, feed for animals, water supply, and other items. Visualize the gasoline requirements of the German Army for one day at 30 million gallons. Estimate the transportation needed for this item alone. In the German invasion of Belgium and France it is said that pipe lines were laid as the troops moved forward, and that fuel was pumped direct instead of being transported by truck and railroad.

In the invasion of Poland (lasting less than 30 days), a recognized masterpiece of military planning that was participated in by approximately 700,000 men, Germany's fuel expense, alone, was 40 million dollars. During the last world war the artillery fire of 3,000 guns for one day cost 300 million dollars; every minute London's anti-aircraft batteries are in action at least 100 thousand dollars' worth of ammunition is fired; for every soldier in the front lines two are required in the service of supply. Production, transportation, and distribution—all these responsibilities fall to the lot of the engineer.

Industrial Organization Also Essential.~The vast expanses of seas separating our shores from all nations that might conceivably become aggressive have, in small part perhaps, been the reason or excuse for the so-called logic underlying our traditional policy of neglecting preparedness for the future. Now, however, the tremendous developments in the speed of all modes of travel and transportation have narrowed these sea barriers to a dangerous degree. The Army and Navy Munitions Board, recognizing the essential technical burdens, called a conference to prepare plans for organizing American industry. Partly as a result, there are now more than 40,000 engineers of various classifications at work on the country's mobilization for national defense.

It might be suggested that preparation for defense most certainly extends into preparation for ultimate offense. Else how can an aggressor be conquered and his activities in the future controlled? It follows, then, that after the factory has been enlarged, the innumerable machine tools made, and the machines of war constructed and their production output maintained, the engineer's task of manning, maintaining, and operating these machines goes right on. Difficulties of mechanization, of so-called social legislation, of shortage of skilled artisans, are well known. Plans and specifications prepared by engineers are not sufficient. We are needed to train welders, carpenters, masons, pipe fitters, steel workers, machine operators, pattern makers, forgers, transmission linemen, and craftsmen in a thousand other categories.

Depends on Engineers.~Illustrative of the time and cost of preparation is the big-gun problem. We are now in need of 16-in. gun carriages. Present arsenal capacity, now speeded up, can produce but four in one year. At first, at a large cost and with much delay, it was proposed to construct a plant to build them. Careful study and planning discarded this plan and the supply will be secured through augmentation of arsenal facilities and by contract arrangements.

If there are bottlenecks and obstructions in the production of all the essential elements, their dilation is our job—the engineer's job. Preparation of plans is estimated to require 20,000 man-years of the time of skilled technicians. Even with all this confronting us, it appears that complete national preparedness will be accomplished by the spring of 1942. However, with increasing patriotism in industry it may be hoped that the job will be practically completed by the late summer of 1941. It is an engineer's job. We must compute every stress and strain; design every structure to withstand every force applied to it. It is estimated that 80% of the personnel engaged in defense preparations consists either of engineers or of others whose every effort is planned, guided, and controlled by engineers. The magnitude of the purely civilian effort of technologists is tremendous.

In Military Units, Too.~Consider the parallel tasks of engineers in the military service. Should we mobilize an army of 4,000,000 men, the purely engineering ratio of this vast force, both officers and enlisted men, will approximate 6 per cent, or 245,000 of the total number. In the German Army this ratio is more than doubled, and it is interesting that officers for construction engineer units are taken from practicing civilian engineers.

With the strength of 1,400,000 now being mobilized, there will be approximately 73,000 Engineer officers and men. In addition, other engineers not definitely classified as such will be used in the Artillery for computation of firing data, map interpretation, erection of field fortifications, and purely technical emergency service; in the Quartermaster Corps on construction, logistics, and lines of communications; in the Signal Corps for procurement and operation of telephone, telegraph, and radio equipment; in the Chemical Warfare Service; in the Ordnance Department for the design and manufacture of tanks and of cannon, small arms, and ammunition; and in many branches for work related to motor transport and air service.

Practical Army Organization.~The range of the military engineer's responsibility is emphasized by a look at the structure of the Army. There are now three classes of divisions—armored, triangular, and square. In the triangular division, one of the three combat arms is a battalion of engineers in three combat companies. This battalion, like its counterpart the combat engineer regiment with the square division, is responsible primarily for satisfactory fulfillment of a number of functions:

(*a*) Engineer reconnaissance.

(*b*) Aid to the forward movement of division troops, which involves:

Constructing, repairing, and maintaining trails, roads, and bridges.
Recommending traffic control methods.
Sign posts and routes.
Removing obstacles, including road blocks and mines.
Procuring and issuing maps.
Camouflage instruction; and

(*c*) Measures to hinder enemy movement, which involve:

Providing tools and materials to our troops for field fortification work.
Constructing special fortification works.
Laying out defensive positions.
Demolitions.
Constructing obstacles and road blocks.
Supplying anti-tank mines and laying mine fields.

Other functions include water supply and employment in emergencies as riflemen.

Knowledge of Arms Needed.~The battalion is provided with much power equipment. For field use this includes air compressors, air- and gasoline-driven power hammers, power saws, large powered earth augers, 9 demolition sets, 4 water purification units of a combined capacity of 3,600 gal per hr, oxyacetylene torches, electric lighting set, 10 assault boats for stream crossings, 3 medium tractors with angle dozers, and other items. For training purposes a road grader and a $^3/_8$-cu yd shovel with pile-driver attachment are also provided.

Assigned to headquarters higher than the division are the corps and army engineer units that are available for special services such as ponton bridging, map reproduction, topographic work, or heavy road and bridge construction. A newly organized engineer aviation regiment will serve with the G.H.Q. Air Force.

The varied duties imposed on engineer officers make it necessary for them to have a general knowledge of all arms, especially infantry. In all our wars they have been assigned to important staff positions and promoted to command divisions just as civilian engineers are appointed to important executive positions in defense industries.

Essentials of National Defense.~Wars today are won by a determined offensive. The success of the mobile offense against the standstill defense has been evidenced. Defense must be as mobile as offense. Vigor, audacity, initiative, speed, and modern weapons must be used on the production as well as the military front.

National defense has two legitimate and logical functions:

(*a*) The preservation of order at home.

(*b*) The prevention of aggression from abroad.

The Army and Navy are but a part of the national defense system in the broad sense. Wars as now carried on are total wars. They affect every part of the nation involved. The vulnerability of cities to aerial attack, the destruction of industries, and the curtailment and diversion of food, supplies, and equipment make it necessary that every citizen play a part. None is more important than the engineer.

FREDERICK H. FOWLER
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Engineers in River-Crossing Operations

Ponton Bridges for H-10 Loading Built at Rate of Five Feet a Minute—Portable Steel Trusses a Feature of Army's New Equipment

By E. P. LOCK, JR.

MAJOR, CORPS OF ENGINEERS, U.S. ARMY; STAFF AND FACULTY MEMBER,
THE ENGINEER SCHOOL, FORT BELVOIR, VA.

MODERNIZING its bridge equipage to keep ahead of advances in motorized fighting methods has been a continuing problem in the Corps of Engineers. Advantages of large-scale portable structures and power tools must be balanced against the increased road space and supply needs entailed. A triangular division halted during a march takes up nearly ten miles of good highway. Major Lock nevertheless relates progress in development work and shows how tactical considerations govern erection methods and influence designs. This is the second of several articles on military phases of engineering arranged through the cooperation of the Chief of Engineers.

OUR army believes in the offensive. If an enemy invades our country, we will seek to carry the battle to him and crush him before he builds up his defense. We do not believe in sitting behind our guns and permitting hostile forces to assume the initiative. The rapid crossing of rivers in the face of the enemy is therefore a very important and vital operation in our scheme of tactics.

A brief outline of the military factors in the attack of a river line is necessary to a full understanding of its technical features. Consider a relatively wide, unfordable river defended by an alert enemy. First examine the far bank. What sort of defensive organization would give us the most trouble? Suppose that the hostile force in the zone where we must cross is a modern division defending a front of ten miles along the X River which is 400 ft wide, varies in depth from 5 to 25 ft, and has a current of about 3 miles per hour. The lightly circled areas and the gun positions shown in Fig. 1 represent a possible scheme of the enemy's dispositions. Our problem is how to get our own force across this barrier so that we can carry our attack to the enemy.

Although the enemy cannot be strong at all points, neither can we. The essence of military tactics is to be stronger than the enemy at some particular point. We hope to attain this local superiority of strength by deceiving the enemy as to our intentions, by secrecy in our movements, and by rapidity of movement. We may conduct a feint with the hope of drawing the enemy reserves away from our main attack.

The point for the main attack is selected at some distance from the feint so that the enemy will be unable to shift his defense forces in time to oppose it. Combat teams of infantry and light artillery are ferried rapidly across the river to establish what is called a bridgehead to cover the crossing of the remainder of our force.

As a minimum objective for the bridgehead, the commander selects terrain which will protect the crossing of the main body from hostile fire and which will provide the main body with adequate maneuver space in which to develop for combat. Once this terrain is secured, the commander regains control of his subordinate units as the first step for subsequent operations.

ENGINEERS AND INFANTRY LEAD ATTACK WITH ASSAULT BOATS
Left, Pre-arranged Parties Rush Boats to River in First Wave
Right, Nearing Enemy Shore

PONTON BOAT LOADED FOR CONVOY

Return now to some of the details of making the crossing. The whole combat team is moved up under cover of darkness to a "forward assembly area." The engineers are equipped with small plywood assault boats that weigh about 200 lb and carry 11 men. These are distributed at 15 or 20-yd intervals along a wide front, say about 1,000 yd, in the forward assembly area ready to be carried down to the river bank. The assault parties are organized in boat loads so that each party will assemble at a designated boat.

At the time set for the attack the boats are carried by hand to the river, launched, loaded with the assault troops, and moved rapidly across in a first "wave."

Each small party lands and fights its way straight ahead to an "initial objective" line. The boats are taken back by a crew of two men to carry across the following waves. As soon as the first wave reaches its initial objective a firing line is built up and the forces are "reorganized"; that is, the small parties are again grouped under their proper platoon, company, and battalion commanders for more effective control in the succeeding actions.

In general, ferrying continues until bridges are completed. The first infantry battalion to cross, after the covering force has secured the ferrying area, initiates action to secure and guard the bridge site, which may or may not be exactly within the ferrying area. The flanks and front of this first battalion are covered by the fire of supporting troops from both banks. As other infantry battalions land, they move to the flanks of the leading battalion. Control by regiments and brigades is gradually regained. By crossing on ponton rafts certain units of attached artillery follow the infantry to furnish close support. The advance to the final bridgehead position (Fig. 1) is made as rapidly as conditions permit. The ponton bridge is then constructed and the tactical situation is logically concluded by immediately crossing the heavier division loads such as artillery, ammunition, and tanks to support the impending advance—the whole movement being accomplished under the protecting fire of the bridgehead troops.

Engineering factors in the crossing are another matter. Ponton bridges usually must be constructed near the sites of destroyed bridges, for the completion of any great length of new road would require a prohibitive amount of time and labor. In selecting a site for a ponton bridge the commander therefore needs a location where roads lead to the near bank and away from the far bank, and this condition is usually found only at sites where bridges or ferries exist or have existed.

As to the equipment itself, the army's present ponton bridge will carry 10 tons safely, and if reinforced with extra pontons will carry about 20 tons. The elements of the bridge include a floating portion supported by pontons and two fixed parts, one on each end, supported by trestles and sills. The floating part is connected to the fixed elements at both shores by "hinge" spans. One "unit of ponton equipage" comprises 4 trestles, 12 pontons, and a floor system, all transported on two-wheeled and semi-trailers.

NEAR TRESTLE BAY GOES UP QUICKLY
Pontons Would Not Be Anchored in Midstream at This Stage but Would Be Launched and Standing by

A unit of equipage provides approximately 250 ft of bridge, the exact length being determined by adjusting the location of the hinge sills and the trestle bays. Four units of equipage, comprising about 1,000 ft of bridge, are assigned to a ponton company. This equipment is held concealed in a rear area and moved forward only at the exactly appropriate moment.

A crew of about 106 men is required to put up the bridge rapidly. Fewer men can be used but this lengthens the time of construction. Equipment is brought up, ponton boats rapidly unloaded and launched, "balk" and "chess" (stringers and planks) are piled near the site, and the bridge is started. With well-trained troops and under favorable circumstances, a bridge of this kind can be constructed at the rate of about 5 ft a minute.

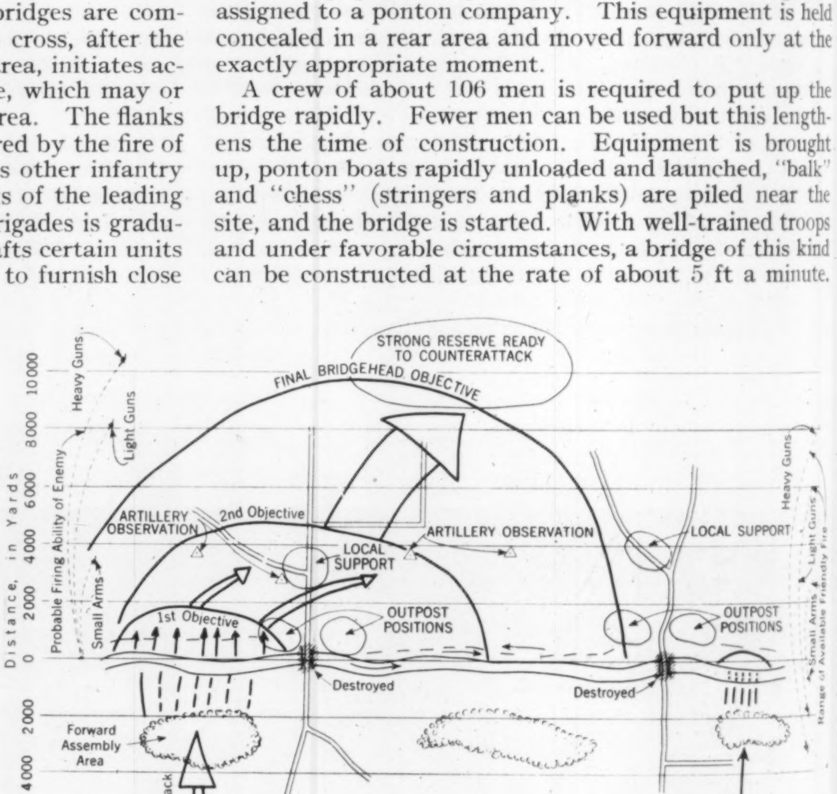
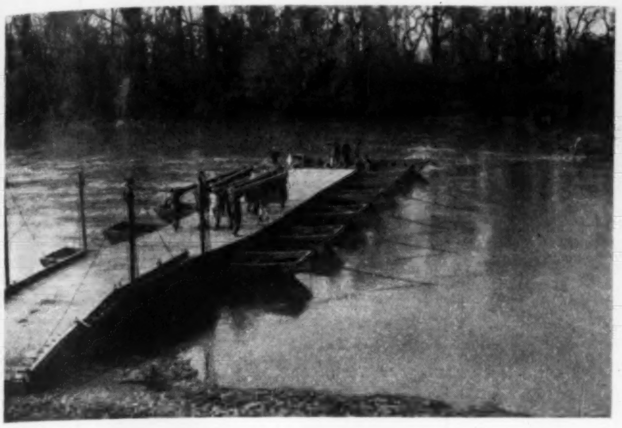


FIG. 1. TACTICS OF A RIVER CROSSING
To Occupy Entire Front Continuously, Defense Would Need Unlimited Force; Attacker Therefore Must Seek Gap, Strive to Achieve Surprise

Under present training conditions, with a rapidly expanding army, few if any units will attain this speed.

General considerations governing the design of military ponton equipment demand that it be capable of rapid assembly. The boats must be simple in design, light, durable, capable of being transported over rough ground and roughly handled without damage, easily repaired, easily managed in water, and not readily injured by being grounded. The present design used in this country meets these requirements very satisfactorily. The 10-ton ponton is flat bottomed and rectangular in cross section between the rakes of the two scow-type ends. It is constructed of aluminum alloy sheets, is not easily damaged, and can be repaired very simply in the field.



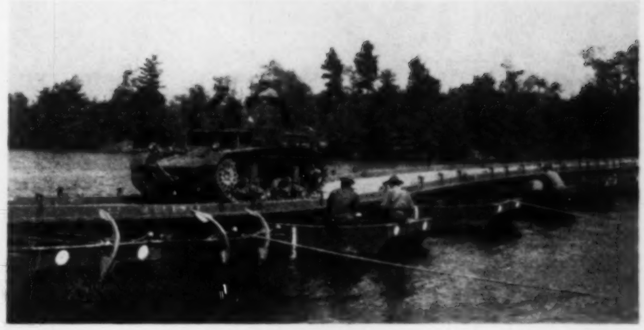
Walking Out the Balk

Two Trestle Spans, Hinge Span, and Five Floating Spans in Place. Note Outboard Motor on Ponton Dropping Anchor at Right

The floor system of the bridge consists of wood balk, 4 in. by 6 in. by $21^{1}/_{2}$ ft long, and a decking of chess, $2^{1}/_{8}$ in. by $11^{7}/_{8}$ in. by 12 ft long. The balk are fastened to the gunwales of the boats with ratchet clamps. The chess are held in place by longitudinal side rails clamped to the outside balk. The stringers and floor planks now used have several advantages—they are light, easily handled, and readily fastened in place. However, the large number of independent operations involved in placing them limits the speed of construction.

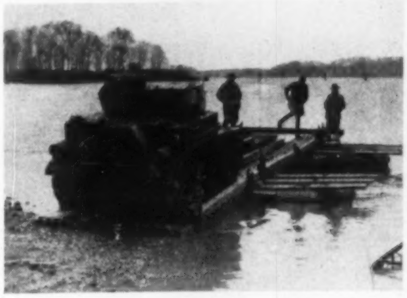
Study is being given to the design of a superstructure consisting of a trackway integrally incorporated in a truss or girder system. With such a floor it may be possible to speed up the construction rate to 10 or 15 ft a minute. The principal design advantage of a truss or girder superstructure is its rigidity. The girder ponton bridge itself functions practically as a single raft, which, by distributing the live load evenly over a number of boats, makes possible the use of the light pontons for extremely heavy concentrated loads.

Wood stringers are relatively flexible. Procurement difficulties and the necessity for simplicity of design impose the use of commercial shapes having a low section modulus. Their large displacement under a heavy load is clearly distinguishable in an accompanying photograph. In the progress of a single load over such a ponton bridge the wave-like motion of the roadway is very marked. If the vehicle travels slowly and the connections are light, these movements are readily calculated. If the speed of the vehicle is increased, the wave-like motion becomes exaggerated. Although the maximum safe speed must be allowed, since a ponton bridge is always a traffic bottleneck, the danger of harmonic oscillations must be avoided by exercising the strictest control.



Heavy Division Loads Are First to Cross

Continuous Girder Action Distributes Weight to Several Boats—Old Rope Lashings Made Superstructure Noticeably Less Rigid



Rafting with Rubber Floats—14-Ton Tank

Deterioration of Fabric Is Drawback to American Use

In the older-type pontons, for which rope lashings were used instead of the present metal connectors, the assumption that joints were rigid was less tenable, and the calculation of stress due to live load could only be made approximately, even for the condition in which the load was stationary. The old bridges were nevertheless suitable for light loads and horse-drawn transport.

One of the foreign armies has made extensive use of inflated rubber floats for ponton bridge supports and rafts. They have been considered by our army in the past, and are now being investigated further. Some disadvantages of rubber pontons are that they deteriorate when stored, require special equipment for inflation, are very quickly deflated, and if used in a bridge require a good deal of special bracing in order to secure the deck. It is possible that further improvement in the durability of rubber-float materials may permit their more extensive use in our army.

As previously indicated, ponton equipment is frequently required for ferrying operations. Two or more boats with the superstructures attached and propelled by outboard motors can be made into a very useful ferry for loads up to five or six tons without using special landing stages. The advent of the 14-ton light tank has considerably complicated the problem. A raft or ferry to carry such a load is not a matter for improvisation. It must be developed and settled upon before the time comes to use it. The crucial problem is not the raft itself but the method of loading and unloading this heavy concentrated load, which cannot be brought directly onto the gunwale of a 10-ton ponton without either grounding or submerging it.

One workable solution using standard equipment is to build at both banks of the stream landing stages consisting of floating bays of the ponton bridge with one or more trestle bays at each bank. These landing stages have the disadvantage of requiring considerable quantities of material and labor to construct. They also form a target for enemy artillery. Ordinarily rafts would be used very early in the attack of a river line, and an artillery hit on a landing stage would be as disadvantageous as such a

PONTON FERRY HAS SUSPENDED RAMP
Difficulty of Loading 14-Ton Tank Without Unbalanced Loading Obviated by Hinging Floor at Buoyancy Center

hit on a ponton bridge. An alternative now being experimented with consists essentially of two 10-ton ponton boats with a tilting ramp on an axle hung between the two boats. Preliminary tests indicate that this ferry will be entirely feasible.

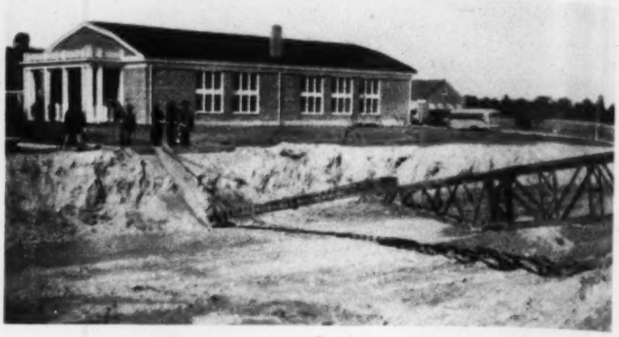
It is usually desirable, as soon as practicable after a floating bridge has been installed, to replace it with a fixed bridge so that the floating equipage may be released for use elsewhere. The types of fixed bridges for such replacements are simple stringer bridges of either timber or steel for short spans, and trestle or pile bridges for longer spans. New masonry piers are rarely appropriate for major military operations but use is often made of those that have been partially demolished.

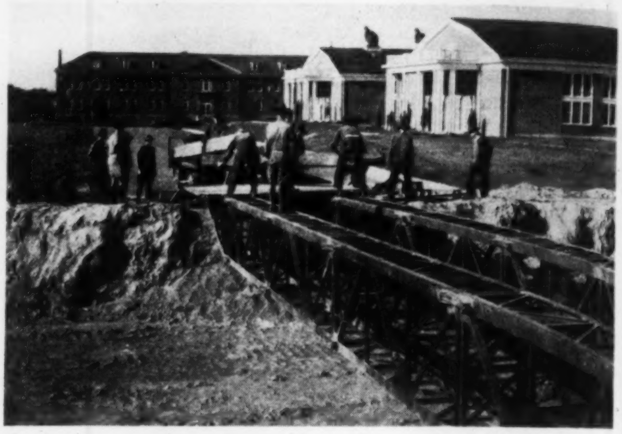
A recent development is a portable steel highway bridge for short spans. Two sizes have been designed and constructed, one for H-10 loading, which approximates the loads found in the division with light tanks and 155-mm howitzers added, and one for H-20 loading. They are similar in design and method of erection. Each consists of two steel girders, carried on trucks in sections for assembly at the site. Each girder is launched as a unit. The floor system consists of 3 by 12-in. planks laid on the girders, and is designed for one-way traffic.

The end girder sections of the H-10 bridge are triangular, and the intermediate sections are rectangular, the latter being interchangeable end for end or top for bottom. Each section is 12 ft long by 2 ft wide by 4 ft deep. Connections between each two sections are made by eight $1^1/_4$-in. bolts passing longitudinally through lugs on the outside and inside of each corner of each section. Carrying positions are provided for these bolts on the section members. A high-strength steel is used throughout, and all connections of section members are welded. Welding saves weight and leaves the top and bottom surfaces of the girders smooth, which considerably facilitates launching operations. The end sections weigh 820 lb each and the rectangular sections 1,140 lb each. The maximum span of this bridge is 72 ft.

To facilitate launching and placing the girder, an auxiliary beam 22 ft long, called a launching nose, with a large wheel at its outer end, is provided. It is attached to the forward end section by pins. The launching nose weighs 390 lb and is jointed with a pin connection to facilitate transport. The assembled girder is launched by pushing it forward on rollers, with the near end counterweighted by the erection crew. When far enough extended it is allowed to drop down so that the wheel of the launching nose strikes the far bank. The girder is then hauled into place by block and tackle.

A trained platoon can erect the bridge in an hour, starting with all the equipment loaded on trucks at the site, and with the abutments prepared. A platoon that had never seen the equipment before put up the bridge in two hours. The bridge has been built without difficulty by a crew of only 17 trained men in an hour and forty-five minutes. Gin poles or derricks are not required.

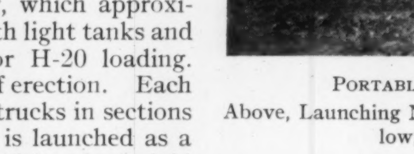




PORTABLE GIRDER BRIDGE FOR H-10 LOADS
Above, Launching Nose and Blocks Used in Swinging Over. Below, Decking for One-Way Traffic

The H-20 bridge can be used for spans up to 125 ft. It does not have the launching nose and requires some special equipment to construct. However, the erection procedure is similar to that for the H-10. A trained crew can put it up in about four hours.

Tactical operations are very materially affected by new developments in equipment. This is particularly true of river crossings. In the constant search for more efficient methods and materials, the Army has already drawn freely from civilian engineering practice. The Corps of Engineers in its recent large expansion has brought into the Army a large number of civilian engineers and is utilizing their judgment and experience to the utmost. It is hoped that this discussion will interest others of the engineering profession in some of our problems.



LAUNCHING AN H-20 PORTABLE GIRDER FOR A 125-FT SPAN

Triangulation for Tacoma Narrows Bridge

Accurate Net Requires Use of Precision Instruments, Special Tripods, and Illuminated Range Rods

By Fred C. Dunham

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FAILURE of this bridge naturally heightens our interest in any aspect of work connected with it. However, the present paper by Mr. Dunham describes the efficient and modern application of precise surveying methods to a staking-out problem made difficult by climate and topography. It has little or no bearing on structural problems, but illustrates field techniques in base-line and coordinate layout that may be helpful on many kinds of construction projects.

THE largest single problem involved in establishing the triangulation system for the Tacoma Narrows Bridge arose from the fact that the PWA time requirements made it necessary to perform practically all the survey work after the start of construction. The procedure had therefore to be so organized that vital points could be established for the contractors as quickly as possible.

For purposes of description, the elements established in the triangulation system may be divided into three distinct groups: (1) the bridge center line and the base lines, (2) the main triangulation stations on both sides of the Narrows and the calculation of coordinates for each point, and (3) the ranges from the various triangulation stations for the easy location of the piers. These elements will be discussed in turn.

General topography at the bridge site is indicated in Fig. 1. First efforts were directed towards establishing two base lines, one on each side of the channel. On the westerly side, however, the only practical place for a base line was along the beach at the foot of the bluffs, where it would be very close to the low-tide line. The 13-ft tidal range would have made both the establishment and the use of such a line very difficult. Along the easterly side of the Narrows, it was found that a base line could be laid along the center line of the double-track railway at the elevation of approximately +14 existing there. Two base lines were therefore established along the easterly side, as indicated in Fig. 2—the first, a broken-back line north of the bridge center line with a total length of approximately 4,052 ft, extending from Sta. 70 + 06.749 to 39 + 08.254 and to 0 + 00 N.B.; and second, a broken-back line south of the bridge center line from Sta. 39 + 08.254 north of the bridge center line to Sta. 70+06.749 on the bridge center line, and south to a station designated "Overhead" for a total distance of approximately 3,260 ft. Because of the fact that train interference made the use of points along these base lines inconvenient, and because the ground upon which the railroad was constructed was susceptible to slight movement, triangulation points were established as speedily as possible from these base lines to the top of the bluff immediately east of the railroad tracks.

On both sides of the Narrows, the center line of the bridge was cleared to a width of 20 ft extending about 8,700 ft from the P.I. on the west at Sta. 9+ to Sta. 96+ on the east. All principal points along the center line and the triangulation points were marked with pipe monuments 6 in. in diameter and concreted into the ground to a depth of 6 ft. All points were referenced with other pipe monuments 4 in. in diameter placed 4 ft in the ground. In selecting monuments for the bridge center line, two points were placed back of each anchorage. Monuments at 21 + 46.767 and 72 + 31.40 were placed at such elevations that a direct sight could be obtained across the channel without interference from the steel work of the structure. This was of great advantage during construction.

After installation of the monuments, the precise center line was established, using the transit theodolites described later and portable radio equipment for communication. Extreme care was taken to insure the accuracy of this line. Sights were taken from both ends of the 8,700-ft tangent, and all points had to line up perfectly

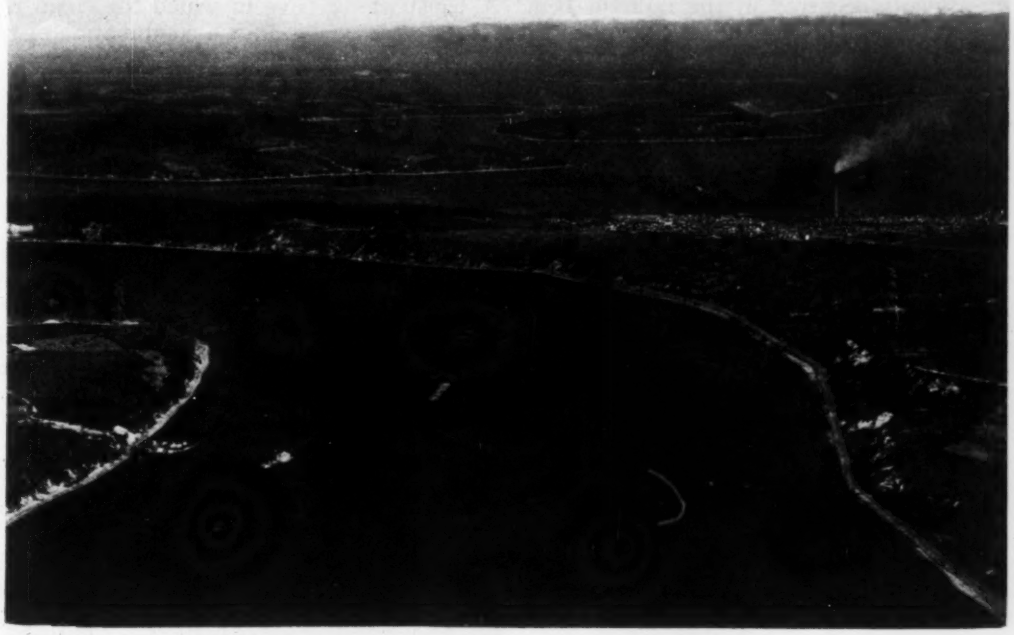

Fig. 1. Tacoma Narrows Before Construction of the Bridge
Rugged Countryside for Triangulation Work—Bridge Site Marked by Start of Pier and Abutment at Left

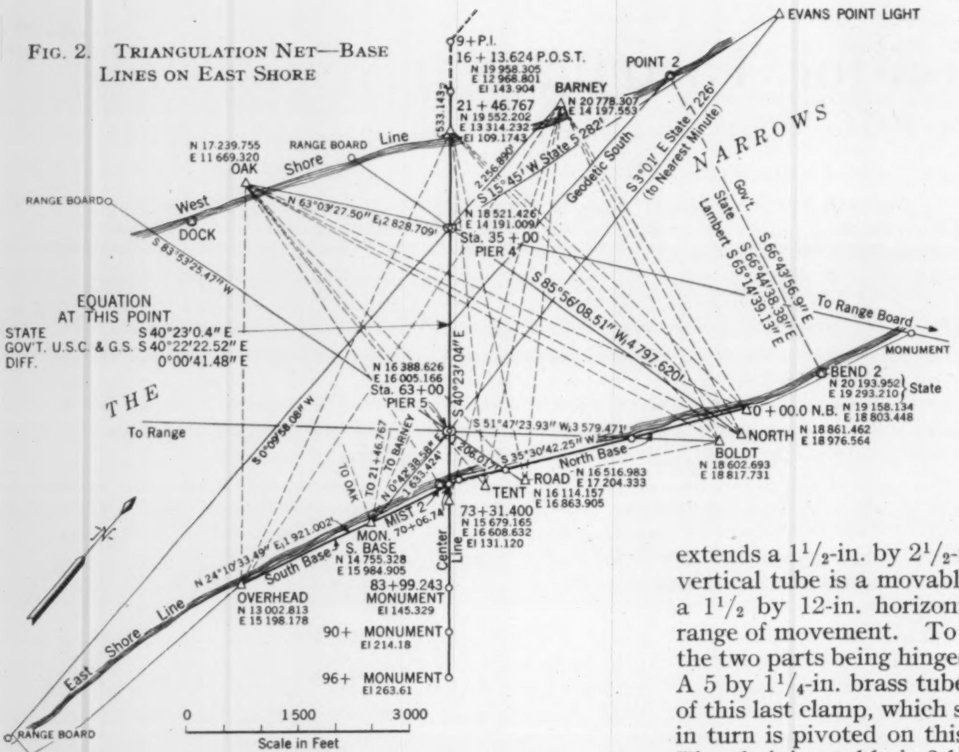
9+P.I.
16 + 13.624 P.O.S.T.
N 19 958.305
E 12 968.801
El 143.904
21 + 46.767
N 19 552.202
E 13 314.232
El 109.1743
533.143
BARNEY
N 20 778.307
E 14 197.553
POINT 2
EVANS POINT LIGHT
N 17 239.755
E 11 669.320
OAK
RANGE BOARD
West Shore Line
RANGE BOARD
DOCK
N 63°03'27.50" E, 2 828.709'
S 83°53'25.47" W
2 256.890'
S 15°45' W State 5 282'
Geodetic South
S 3°01' E State 7 226' (to Nearest Minute)
NARROWS
N 18 521.426
E 14 191.009
Sta. 35 + 00
PIER 4
Gov't. S 66°43'56.9" E
State S 66°44'38.38" E
Lambert S 65°14'39.13" E
To Range Board
MONUMENT
S 85°56'08.51" W, 4 797.620'
EQUATION AT THIS POINT
STATE S 40°23'0.4" E
GOV'T. U.S.C. & G.S. S 40°22'22.52" E
DIFF. 0°00'41.48" E
S 40°23'04" E
N 16 388.626
E 16 005.166
Sta. 63+00
PIER 5
BEND 2
N 20 193.952
E 19 293.210
State
0 + 00.0 N.B.
N 19 158.134
E 18 803.448
THE
To Range
S 0°09'58.08" W
S 51°47'23.93" W, 3 579.471'
NORTH
N 18 861.462
E 18 976.564
S 35°30'42.25" W
North Base
BOLDT
N 18 602.693
E 18 817.731
TO OAK
TO 21+46.767
TO BARNEY
N 0°42'38.58" E
1 633.424'
206.017'
ROAD
N 16 516.983
E 17 204.333
TENT
N 16 114.157
E 16 863.905
MIST 2
70+06.74
MON.
S. BASE
N 14 755.328
E 15 984.905
73+31.400
N 15 679.165
E 16 608.632
El 131.120
Center Line
N 24°10'33.49" E, 1 921.002'
South Base
OVERHEAD
N 13 002.813
E 15 198.178
83+99.243
MONUMENT
El 145.329
90+ MONUMENT
El 214.18
96+ MONUMENT
El 263.61
East Shore Line
RANGE BOARD
0
1 500
3 000
Scale in Feet

FIG. 2. TRIANGULATION NET—BASE LINES ON EAST SHORE

when sighted from either end. This work was done between November 19 and December 2, during which time the climate was a combination of rain, fog, haze, wind, and clear weather. Nothing could be accomplished during periods of sun or high wind because sunny weather gave bent light rays and high winds made the instrument unstable. The best results were obtained on dark cloudy days or in a quiet rain.

The two base lines were alined in a similar manner and under similar weather conditions. Additional difficulties were experienced, however, in that air conditions in the lee of the bluff were quite unstable. Also, small movements occurred in the railroad bed. A constant check was kept for alinement until all points were finally transferred to the triangulation stations on the bluff, with satisfactory results.

For chaining the base lines, standardized tapes and special chaining tripods were developed. Full stations were measured by 100-ft, temperature-inert tapes certified by the Bureau of Standards. Intermediate distances were measured with white-faced steel tapes, also certified by the Bureau. The temperature-inert tapes were of a soft metal having a coefficient of expansion of 0.00000056. They were marked at the zero, 50, and 100-ft points. These tapes were all handled very carefully, and were not permitted to drag on the ground. Generally three men carried them when moving. Chaining was done over metal chaining tripods which supported the tapes at zero, 50, and 100-ft points. These tripods were similar to those used on the San Francisco–Oakland Bay Bridge but redesigned and improved for this work. In addition to the three supporting tripods, two tripods were used at each end to sustain tension weights of 20 lb each. When in use in the field over this equipment, the tape was suspended under conditions similar to those under which it was standardized.

Equipment used in chaining is shown in Figs. 3 to 6. The chaining tripod (Figs. 3 and 4) is all metal with heavy rim shoes set at such an angle to the tripod legs that the shoes will be approximately perpendicular to the ground at almost any position of the tripod. The top of these shoes has a round cap which can be hammered upon to set the shoes firmly in any material. The legs are attached to a wide bronze center through which extends a $1^{1}/_{2}$-in. by $2^{1}/_{2}$-ft seamless brass tube. On this vertical tube is a movable clamp through which extends a $1^{1}/_{2}$ by 12-in. horizontal brass tube having a 10-in. range of movement. To this is fastened a double clamp, the two parts being hinged at approximately right angles. A 5 by $1^{1}/_{4}$-in. brass tube is set into the vertical portion of this last clamp, which supports a chaining table, which in turn is pivoted on this short post over a rocker arm. The chaining table is 2 by 5 in., with two thin strips of metal $^{3}/_{8}$ by 2 in. fastened parallel to the longest dimension and spaced a trifle farther apart than the width of the tapes. On these metal strips is scribed a mark to which either the zero or the 100-ft end of the tape can be matched. The whole table is movable by means of two opposing tangent screws. The top of this small table is slightly curved in the long dimension to allow for the sag of the tape.

The center support tripod (Fig. 3) was similar to the chaining tripod with the exception that instead of the chaining table a single wheel on roller bearings is used as the vertical support. This wheel has a flat $^{5}/_{8}$-in. groove in which the chain rests. The backstay tripod (Fig. 5) is a combination of wood and metal. The back

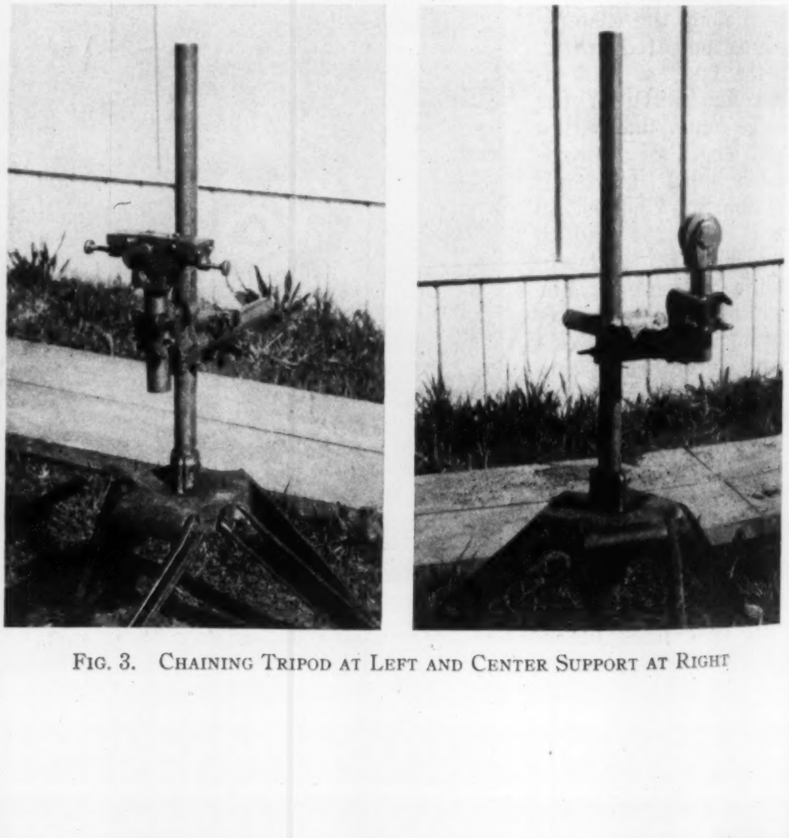

FIG. 3. CHAINING TRIPOD AT LEFT AND CENTER SUPPORT AT RIGHT

legs of the tripod are separated by two horizontal metal pipes 3 ft apart, to which is fastened a vertical pipe in such a way that it can be moved sidewise. Working up and down this pipe and clamped to it is a $2^3/_4$-in. grooved pulley over which the weight wire is run. This arrangement, together with the setting of the frame, allows quick and easy adjustment, as illustrated in Fig. 6. Experience indicates that this equipment is very satisfactory, and can be used also for slope chaining up to about 15%.

Each of the base lines was chained a total of four times. The two 100-ft temperature-inert tapes and the two white-faced steel tapes were interchanged. Two measurements were made with each tape and the results averaged, because, even though the tapes were standardized, it developed that their exact lengths varied by 0.001 ft.

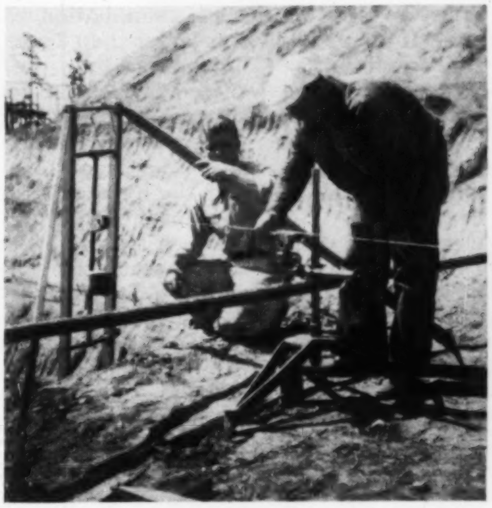
Fig. 5. Head-End Tripod and Backstay

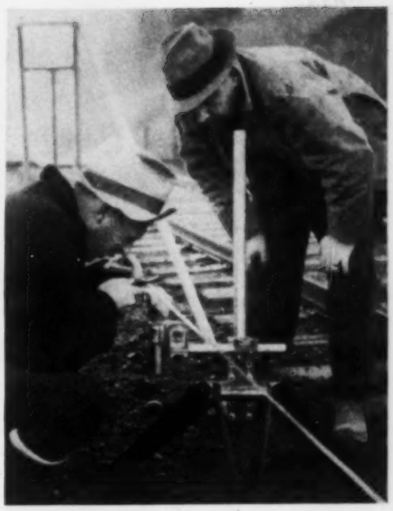
Fig. 6. Rear Chainman Adjusting Chain to Table Index

As a preliminary to the actual precise chaining, the base lines were hubbed through on 50-ft intervals using a black-faced steel tape, spring balance, and temperature correction. A tack was set in each 100-ft hub after field correction for temperature. Levels were then run over these hubs and exact distances computed. Experience indicated that the slope chaining was more convenient and faster than the horizontal.

Precise chaining followed this preliminary work. A chaining table was set up over the initial point, which was transferred to the table with the aid of a transit set at right angles to the line a short distance away. The center support and head chaining tables were then placed in approximate position using the 50-ft-interval hubs. The elevation of the rear chaining table was taken by level and the center support and head chaining table set to grade. The backstay tripods were set at each end, the tape placed on the end chaining tables and center support, and the weights attached to the chain at each end by 10 ft of flexible wire, with a swivel between the chain and the weight. The rear chainman then brought the zero line on the tape to coincide with the lines on the metal guide stripes on the chaining table.

Next the head chainman adjusted the table indices to the 100-ft line on the tape. A temperature reading was taken and recorded, and the equipment was moved ahead of the head chaining table to a new position and the operation repeated. When pluses were desired to intermediate points, they were obtained by using the 100-ft white-faced steel tape and were read by transits placed at right angles to the tape. Readings were taken from two adjacent 100-ft stations by reversing the tape, and the two readings were compared. It was found impossible to chain in any wind except the very lightest, as the wind caused the chain to run slightly back and forth. Fog and rain were not much of a hindrance, as was shown by a comparison of results of chaining in both wet and dry weather.

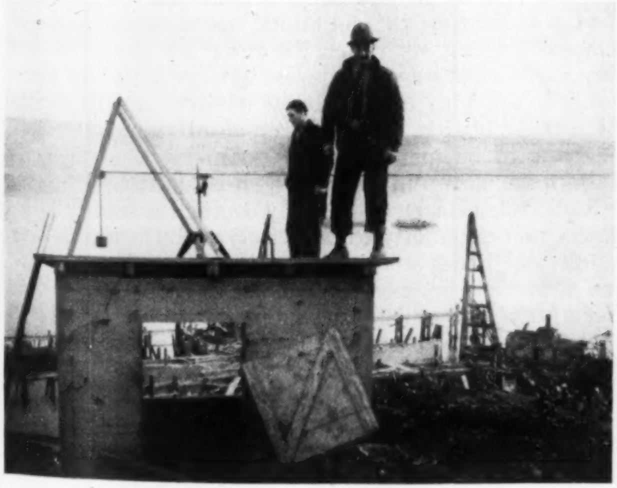
Fig. 4. Rear Chain Tripod Atop Triangulation-Point Shelter House

The field party for this work consisted of from eight to nine men: an instrumentman in charge of party, a recorder, a levelman, and five or six men handling the chain and chaining equipment. On an average day about 3,000 ft could be chained. None of the men had had any previous experience in this type of precise work. They were, however, experienced in general highway and bridge work.

After establishment of the base and center lines, the next step was to place the main triangulation points as indicated in Fig. 2. On the east these points were "North," "Boldt," "Road," "Tent," and 72 + 31.40, all on top of the bluff, and "Overhead" at the lower level adjacent to the railroad tracks. Along the westerly side at the top of the bluff, four convenient points were chosen: "Oak," 21 + 46.767, 22 + 98.543, and "Barney."

From the north base line, two triangles were developed to each station on the west using for a base 0.00 N.B. to 39 + 08.254 for one triangle and 0.00 N.B. to 70 + 06.749 for the other. For the south base, two triangles were likewise developed to each station on the west using for a base "Overhead" to 70 + 06.749 in one case, and "Overhead" to 39 + 08.254 in the other case. This method resulted in four sets of slightly different coordinates for each west-shore station, and the average was finally accepted as the final coordinate. The triangulation points on the easterly side were established from the base lines by triangulating from points along them to points on top of the bluff.

The angles were measured by the use of transit theodolites having a horizontal limb graduated to 10 minutes of arc with verniers reading to 10 seconds. The instruments have very sensitive plate bubbles and in addi-

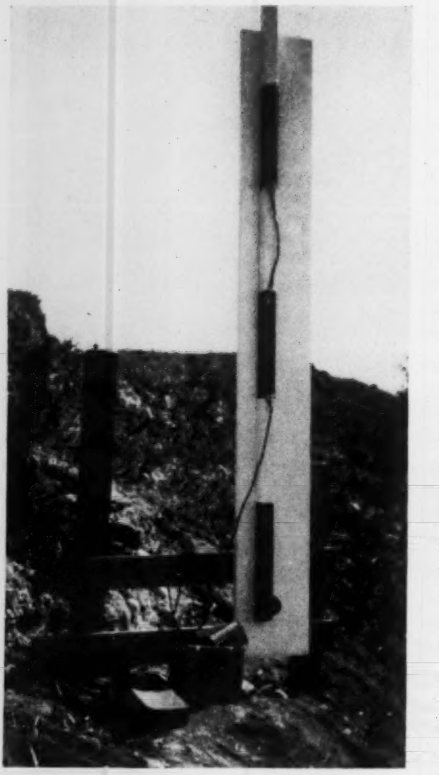

FIG. 7. ELECTRICALLY LIGHTED RANGE ROD FOR NIGHT WORK

tion a striding level of about 20-sec sensitivity. The telescopes are inverted with internal focusing and have a magnification of 40 diameters. By means of a battery-operated lighting system, the vernier plates and cross hairs can be illuminated. Vertical cross hairs are a pair subtending an arc of 30 sec. Shelters for the instruments were constructed over all principal triangulation stations. For night work, range rods were illuminated by arranging four small electric bulbs in parallel along the rod about one foot apart (Fig. 7). These could be seen distinctly up to four miles. During most of the triangulation period angles were measured in the day time. However, a small part of the work was done at night and the results were much more consistent. In general, it was endeavored to do this part of the work on cloudy or rainy days.

Angle turning was carried out by the method of repetition. Four sets of 12 readings were taken with four different points on transit for the zero point. The instrument was first sighted directly and 6 turnings made. It was then transited and turnings were continued until 12 readings were obtained. This had the effect of double centering the angle. The average of 4 sets of 12 readings each was taken as the field value of the angle. The instrumentman was at liberty to discard any set of angles that did not seem consistent and to remeasure them. The aim was to read all angles at any given point at a given setting although at times this was not possible because of construction activities. When all readings about a given point had been obtained, the error in summation was apportioned equally among the angles. The basis for this treatment was the assumption that the angle error was an error of pointing and therefore would be the same for a small angle as for a large one. When all the three angles of any triangle had been measured, a summation was made in the field, and if the error was larger than 3 sec, the triangle was reworked. In the office procedure, the angles used for the triangles were those at which the point adjustment had been made. A summation of the angles in each triangle was made and the error was distributed among the angles. The average adjustment to angles about points was 0.596 sec, and the average adjustment for triangle error 0.86 sec.

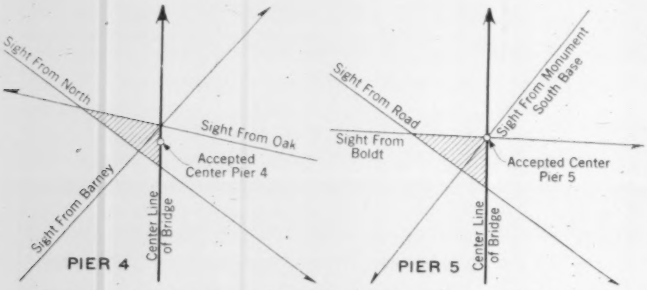

FIG. 8. ACCURACY OF PIER CLOSURES—SCALE FULL SIZE

Before computing the final courses and distances between triangulation points on the west side and those on the east side, a closure was computed from Sta. 21 + 46.767 to "Oak" and to "Barney," respectively. These computed courses were run from Sta. 21 + 46.767 to "Oak" and to "Barney." The course to "Oak," a computed distance of 2,837.807 ft, missed in direction by 0.016 ft. The line to "Barney " a computed distance of 1,511.155 ft, missed in direction by 0.005 ft. The courses were not chained. In view of these results, it was considered that the coordinates of these three points, as derived by triangulation from the two east base lines, were as close as could be practically obtained. Thereafter, all field surveys were developed from the triangulation points with little reference to the base lines.

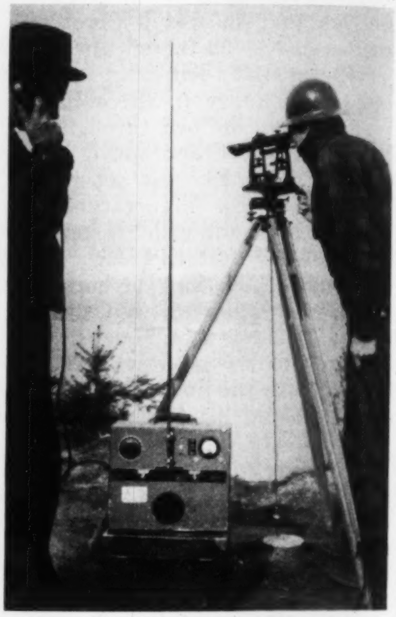

FIG. 9. FIELD RADIO—PORTABLE SET

The most important use of the triangulation system was in determining precise station points for Piers 4 and 5.

The center line was, of course, a definite alinement. Three additional lines intersecting it were established from the triangulation points to range boards set for each line. These ranges were established by first setting a range board by instrument in closely approximate position. Triangulation angles, using sets of 48, were then read from all visible points to this range. The average of the courses so obtained was compared with the computed course by which the range had been set and the range board moved sidewise the computed amount. Range poles with electric bulbs were then attached to these range boards, since the actual intersection on each pier was to be made at night. Intersections at Piers 4 and 5 are shown in Fig. 8, which is full size.

Radio was utilized extensively during the triangulation survey and the ability to talk easily with the men taking sights was invaluable. Six sets were used—one large one in the field engineer's office, which served as the control station and which was attended by a licensed operator, a second similar set mounted in the engineer's boat, and four field sets which weighed about 30 lb each and could be easily carried from point to point (Fig. 9).

The work described was under the direction of the Washington Toll Bridge Authority, L. V. Murrow, Assoc. M. Am. Soc. C.E., chief engineer, and Clark H. Eldridge, M. Am. Soc. C.E., bridge engineer. The writer was field engineer on the project.

Bacterial Contamination Improbable as an Implement of War

By Carlo G. Flebus, Assoc. M. Am. Soc. C.E.

Consulting Engineer, New York, N.Y.

THE possibility of an enemy deliberately spreading an epidemic by polluting the water supply of a city has often been discussed. But it is improbable that resort will be had to this dreadful method of warfare—not because humanitarian considerations may be expected to sway an enemy who wages total war, but because the desired results would not be assured.

Repeated experiments made by various European powers on the pollution of reservoirs have given totally negative results. Owing to the nature of these experiments they were shrouded in the utmost secrecy, and the results were withheld from the public. However, during my last visit to Europe, I had the opportunity to discuss this phase of warfare with well-informed medical officers who had participated in the experiments. Though I am not sufficiently versed in the technical details to discuss the matter academically, I believe that I can give certain data that will be of interest.

The mere fact that a certain type of pathogenic bacteria is present in a body of water does not necessarily mean that persons who drink the water will immediately contract the disease. Much depends on the quantity of bacteria absorbed at one time and on the ability of the individuals concerned to resist the infection.

Most pathogenic bacteria and parasitic protozoa are mesophilic (requiring blood temperature), and are very sensitive to changes of media, ambient temperature, hydrogen ion concentration, and negative or positive ionization of the air. Studies of pathogenic bacteria cultivated in artificial media have shown that their virulence, aggressivity, and prolificity when injected in a subject are markedly less than those of species which have developed in a natural medium.

It appears that each continent, besides having its own climate, seasonal changes, and atmospheric ionization, has its own particular bacterial flora. Acclimatization and growth elsewhere vary extensively with the species and method of transplanting. It has been observed that only well-developed colonies survive when the transfer occurs within the original host, and a latent state occurs as soon as they have left it. Cultivated bacteria very seldom survive in a new environment. The water in a large impounding reservoir therefore can only be contaminated by aboriginal bacterial flora, and then only when local conditions are such as will foster the growth of the organisms.

Of 42 or more commonly known diseases caused by bacteria, few are caused by spore-bearing types. The majority are caused by mesophilic types which will not survive over eight days in a body of fresh water. Present prophylactic measures taken by health authorities are sufficient to impede the development of an artificially provoked epidemic.

While bacteriological studies definitely discard the possibility of contaminating a water supply by dropping bombs containing artificially cultivated disease bacteria, they do not rule out the possibility of contamination by saboteurs dropping soiled matter and infected articles in the water, or causing sewage to discharge into sources used for human consumption. After discussing this subject with well-informed members of the medical profession here and abroad, the writer is of the opinion that an epidemic in a nation at war is less likely to occur because of enemy action than because war activities may divert the attention of health departments from their routine prophylactic duties.

Large quantities of infected material are necessary to poison a large reservoir; however, it would be possible for a saboteur to poison filters, small reservoirs, stand pipes, and so forth. To provide against this danger and at the same time avoid expensive and delicate analyses, before the water is delivered to consumers a part should be by-passed through an artificial brook where mountain trout are cultivated in a natural environment. These fish are very sensitive to the slightest change in their water supply, and sharply react to poison of any nature, organic or otherwise, by coming to the surface, emerging their heads, and breathing heavily. In large cities where this method may not be feasible, colorimetric chemical analysis for various inorganic poisons can be developed, and used as a part of the regular daily routine.

The chief American breeding grounds of serious bacterial diseases are the South and the tropics. In the summer months particularly an epidemic may develop in northern latitudes through the importation of infected hosts. Modern ships and aeroplanes afford easy transportation for disease carriers. These carriers—mosquitos, rodents, and parasitic insects—are the most dangerous disseminating agencies.

It is the writer's belief that present routine water supply examinations—determination of the 5-day B.O.D. and of the B.coli content—are indicative only and not conclusive evidence that a certain body of water is fit for human consumption. In determining the B.coli content and in preparing samples for culture, non-filterable viruses of less easily detectable pathogenic organisms are not taken into account. The medium and the temperature of cultures in the present test inhibit the growth of practically all the intermediate types of coli bacteria (citrobacters, aerobacters, etc.) which are present in water. These are not considered of any particular sanitary significance, although the biological process of water purification depends to a large extent upon their presence in certain quantities.

Although the clarification and purification of water is a recognized biological process, at present there is no standard biological examination for some species or groups of species of plankton protozoa which show a clear-cut reaction to the presence of septic matter and serve as indices of pollution. A quantitative determination for such species would give valuable information, and if supplemented by chemical and bacteriological analyses, would present a true picture of phases and stages of contamination. In certain countries of Europe such biological and ecological determinations are made, based upon test data collected throughout that particular country over a ten-year period.

It is my understanding that this method, which constitutes a simple way to collect valuable data, has been initiated only recently in the United States. Such studies should be developed throughout the country all year round, in various latitudes.

Cavitation Laboratory Practice

Air and Water Models Used to Evaluate Turbine Performance and to Find Portions of Blades Which May Induce Cavitation

FROM THE POWER DIVISION PROGRAM AT THE
SOCIETY'S CINCINNATI MEETING

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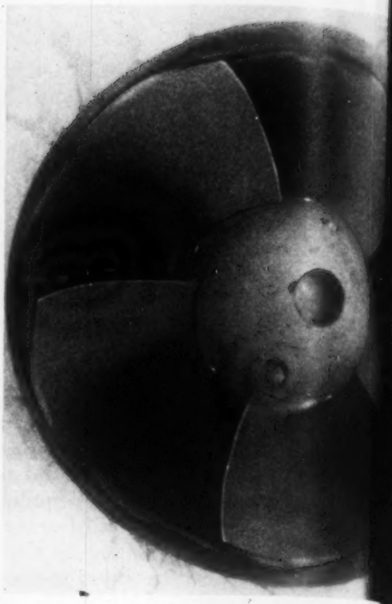
HOLTWOOD, PA.

THERE are two distinct services which the cavitation laboratory is called upon to render. One is to determine the cavitation characteristics of a given design of turbine and to present them in such a manner that comparison with other designs is possible. This permits a determination of the proper turbine setting in relation to tailwater levels and the safe operating power limits for various head conditions. The other service is to provide assistance in improving the cavitation characteristics of a turbine by indicating those portions of the blade where slight modifications in design may improve flow conditions and eliminate low-pressure zones. The method to be employed in conducting tests will depend to some extent on the purpose of the tests. It is evident that tests which give data accurately defining the cavitation characteristics of a turbine may or may not be of much value in improving the design.

Each of the various methods of cavitation testing has its advantages and disadvantages. Undoubtedly the first method employed was the visual method of studying model turbines while they are being operated under cavitation conditions. In order to see the runner while in operation it is necessary to provide a window or windows in the draft tube or make the throat ring and a portion of the draft tube of glass or some transparent material. To get an intelligible picture a stroboscope is necessary. This method is particularly valuable as an aid in design, since the points on the blade where cavitation first occurs can be located. However, it does not give any indication of the effects of cavitation on the power and discharge characteristics. In a paper presented before the spring meeting of the American Society of Mechanical Engineers (*Transactions*, A.S.M.E., October 1940), R. E. B. Sharp included some very interesting stroboscopic photographs of a model turbine in operation. As can be seen from Fig. 1, the places where cavitation is occurring on the blades are readily discernible.

In this same paper Mr. Sharp described a novel device for determining the point at which cavitation commences without making the elaborate tests to be later described. An insulating plug $^7/_8$ in. in diameter was set in the throat ring with two wire inserts placed on the horizontal axis $^5/_{16}$ in. apart, and finished off flush with the throat ring. The plug was so located that the wire inserts would be near the trailing edge of the blades. A voltage was put across these wire inserts with a microammeter in the circuit so that the current flowing across the inserts could be accurately measured. The device indicates the change in resistance brought about between the wire inserts when the solid water column breaks up under the influence of cavitation. Of course this device can only be expected to show the presence of cavitation at the surface of the insert, and cannot be affected by cavitation at other points in the runner.

The generally accepted method of determining the cavitation characteristics of a model turbine is to run tests over the entire operating range, observing the effect of various head conditions on the power and discharge characteristics. The procedure used in this country on an adjustable blade or Kaplan turbine is first to determine the efficiency characteristics for various blade angles over the operating range at a high value of the Thoma parameter, sigma, so that cavitation will not affect the results. This is accomplished by making tests for each blade angle at appropriate gate openings and at various combinations of head and speed to cover the desired range of phi corresponding to prototype speed and head conditions. Observations of headwater and tailwater elevations, speed, power output, and discharge are made. The value of phi for any run is computed from the head and speed readings; the power and discharge are converted to unit quantities; the efficiency is computed; and the last three values are plotted against phi.



Courtesy Baldwin Southwark Corp.

FIG. 1. THROUGH A GLASS UPWARD—B
AND HUB OF MODEL TURBINE RUNN

Bright Areas Are Layers of Small A
and Water-Vapor Bubbles Which
Appear as a Mist

With data of this kind for the various blade angles (usually seven or eight blade settings are provided on a model turbine) the efficiency, power, and discharge characteristics of the turbine can be obtained for various values of phi by cross plotting. As described by the writer in "Model and Prototype Tests" (in the symposium on "Trend in Hydraulic Turbine Practice," PROCEEDINGS, Am. Soc. C.E., November 1939, p. 1575), it is a simple matter to step the model data up to obtain reasonably accurate performance curves for the prototype.

To determine the cavitation characteristics, tests must be repeated for each blade angle. Three gate openings which bracket the best combination of blade angle and gate at each of four or more values of phi, covering the desired operating range, are chosen. The individual gate curves shown in Fig. 2 are obtained by keeping the gate and phi constant and varying the headwater and tailwater levels to change the ratio between draft head and total head. The same observations are taken for these tests as for the efficiency tests. From the following formula defining sigma, it is evident that as the draft head increases, if the total head remains constant, the value of sigma decreases:

$$\sigma = \frac{H_B - H_V - H_D}{H_T}$$

where H_B = barometric pressure, in feet of water
H_V = vapor pressure, in feet of water

H_D = draft head, from center line of runner to tailwater

H_T = total head acting on turbine

An inspection of Fig. 2 shows that the power and discharge characteristics of the turbine are constant for the higher values of sigma, but when sigma is reduced below a certain value the power output starts decreasing and the discharge starts to increase. The value of sigma at which this phenomenon takes place is called the critical sigma for any given set of conditions and indicates the starting point of cavitation.

With data similar to those shown in Fig. 2 for the various values of phi and blade angle, the values of unit discharge at peak efficiency and the corresponding value of critical sigma are plotted, and lines of constant phi are drawn as shown in Fig. 3. The use of the unit discharge values at peak efficiency instead of gate opening eliminates any error in gate setting between the efficiency and cavitation tests.

In Europe the usual method of determining the cavitation characteristics of a model turbine is to run complete efficiency tests at numerous values of sigma. By cross plotting the data at different phi values from these various tests, a curve similar to Fig. 2 may be obtained. When the Holtwood Laboratory went into operation in 1930 this method was in general use. There were several reasons why it was abandoned in favor of the one just described in detail. When complete efficiency tests are run at various values of sigma there is a tremendous duplication of work, since, in order to cover the full range, portions of the phi curves are repeated time after time before the effects of cavitation alter the characteristic. Unless the phi curves are run at fairly small steps of sigma change, thus greatly increasing the work, it is difficult to accurately define the values of critical sigma. When individual gate curves are run at constant phi and variable sigma the break can very quickly be located approximately by reducing the sigma between runs in large steps and then accurately defining the break with numerous runs near the critical sigma. Since it is almost impossible to reproduce exactly the same gate setting, another uncertainty is introduced when an attempt is made to cross plot to obtain sigma curves from phi curves run at variable values of sigma.

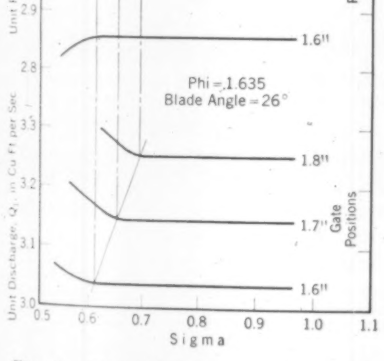


Fig. 2. Sigma-Cavitation Tests on a Well-Designed Propeller

For the past five years the Escher Wyss Laboratory in Europe has been testing hydraulic turbines with air instead of water. Two variations in set-up have been used with equal success. In one set-up a fan forces air into a scroll case, through the gates, turbine, and draft tube to an equalizing chamber. The air is discharged to atmosphere from this chamber through a calibrated nozzle where the quantity of flow is measured. Precision pressure measurements at the entrance to the scroll and in the equalizing chamber give the effective head on the turbine. The power output is measured in the usual manner employed in the hydraulic laboratory. In the other set-up the fan is connected to the discharge end of the equalizing chamber and used to exhaust the air from the system, drawing the air in at atmospheric pressure through the wicket gates.

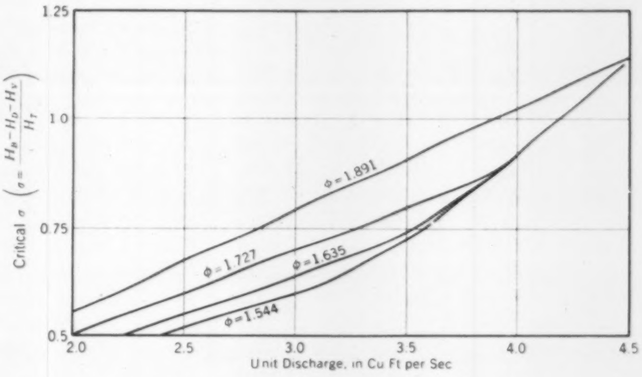


Fig. 3. Variation of Critical Sigma with Unit Discharge for Different Values of Phi

At first glance the use of air as a test medium to replace water brings a number of serious doubts to the mind of the hydraulic engineer, who is in the habit of dealing with an incompressible medium. However, it can be shown that by limiting the air velocities to about 100 to 150 m per sec (328–492 ft per sec) the error due to the compressibility of the air is negligible and there is no essential difference between the use of water and the use of air. These limiting velocities are well above the velocities employed in testing hydraulic turbines with air. It can also be shown that the values of Reynolds' number are approximately the same for a given size of model tested in water and in air. Furthermore, comparative tests made on the same turbine, setting, and draft tube in water and in air show excellent agreement.

In order to obtain data for improving blade design, the Escher Wyss Laboratory equipped blades of an 8-bladed model turbine with 20 piezometers each, distributed over both the pressure and suction surfaces of the blade so that the pressures along three cylindrical sections could be determined accurately. The piezometer pipes were carried into the hub and terminated in such a way that each pipe could be isolated, and the pressure transmitted through the hollow turbine shaft to a stationary accumulator ring where it could be measured. The device was made so that the pressures at the various piezometers could be measured in rapid succession without shutting down the unit.

By plotting the pressure diagrams and computing the pressure corresponding to the vapor pressure of water, the portion of the blade that will be subjected to cavitation is determined for the conditions of the tests.

There are several reasons why the aerodynamic laboratory may become popular in this country in the future for conducting tests on hydraulic turbine models. The space requirements are considerably less than for tests using water on similar sized models. There are also many laboratories that are restricted by lack of sufficient water supply. The air models can be constructed more cheaply, since wood and plaster of paris are suitable for them, while expensive metal construction is necessary with water.

Erection Methods on Baton Rouge Bridge

River Transportation from Plant to Site Speeds Schedule; Piers Checked for Temporary Overturning Loads

By E. L. DURKEE, M. AM. SOC. C.E.
RESIDENT ENGINEER, BETHLEHEM STEEL COMPANY

CONSTRUCTION engineers in this country have a well-earned reputation for appreciating the value of time. Mr. Durkee's exposition of the logical and economical procedures worked out to suit this particular problem suggests the kind of quick thinking that may help to complete other much-needed work ahead of expectations. Among other things he explains the use of jacks in making closure, the method of stepping the derricks, and the handling of materials. The substance of this paper has been given in recent talks before several of the Society's Local Sections.

STRANGE as it may seem at first thought, both high water and low water on the Mississippi delayed construction of the Baton Rouge Bridge. Contracts were let in June 1937, and the original schedule contemplated completion of the underwater work on the two central piers, 3 and 4, before the end of the year. However, high water and other unforeseen difficulties delayed this work for almost a year, until the spring of 1939.

The bridge is designed to carry H-20 highway traffic in two two-lane highways 20 ft wide, supported outside the two main trusses. The single railway track (E-60 loading) is placed between these trusses, which are 32 ft apart. There is no sidewalk except for a 30-in. emergency walk on the outside of each roadway. A 40-in. wide checkered steel-plate walkway is provided on one side of the railway track. There are ornamental structural steel handrails of heavy construction on both sides of each roadway and a wire-rope handrail along the outside of the walkway plate. A sketch of the structure is shown in Fig. 1.

LOW WATER AND ICE DELAY "SECOND OPERATION"

Field work on the steel superstructure was started in March 1939 and the first operation, consisting of erection of main trusses, railroad floor and bracing on Piers 3 and 4, was completed and the span connected in August. Then, in September 1939, what was known as the second operation was started—erection on Piers 2 and 5, from which all remaining steel was to be placed. It was here that low water caused trouble, delaying material barges as much as four weeks in transit. The lowest river stage of many years obtained through November and into December. Then Nature played still another trick on the schedule by freezing the Ohio and upper Mississippi solid early in January, thus stopping barge movement altogether. Louisiana had its most severe winter in 56 years, with a temperature as low as 6 F. Early in February, when the upper rivers thawed, ice cakes 20 ft across floated past Baton Rouge, a sight seldom seen before by the inhabitants.

Steel erection on the second operation and connection of the rest of the spans were finally completed by the middle of March 1940. Erection of highway steel, pouring of concrete roadway slabs, and other details were finished by June 20, but the formal opening was delayed until August 10 pending completion of the necessary approach roads. In spite of these delays, the actual erection was greatly expedited by a carefully worked-out procedure.

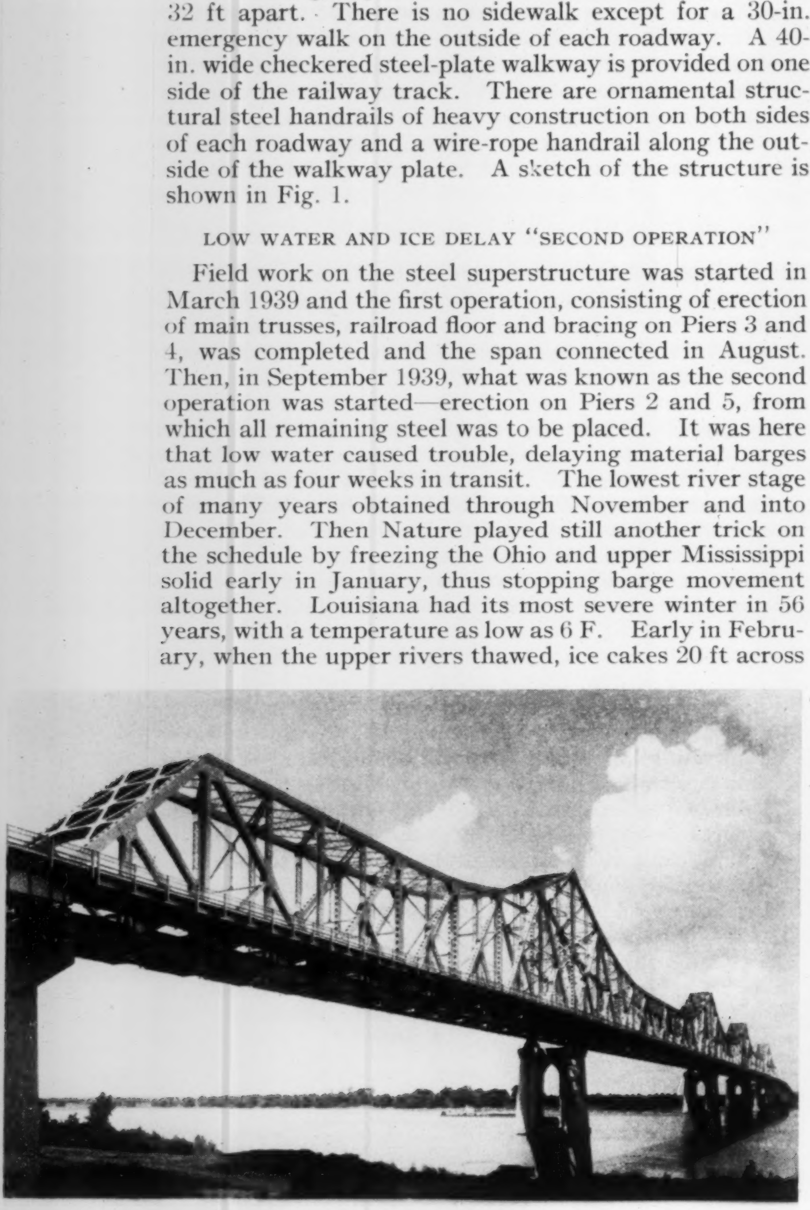
All structural steel for the main river spans was fabricated at the Rankin Plant of the Bethlehem Steel Company in the Pittsburgh District. This plant lies on the bank of the Monongahela River only a few miles above its junction with the Allegheny, the confluence of the two streams forming the Ohio River. Since the major portion of the main spans was over the river, and since shipment by water is much cheaper than by rail, the obvious method of transportation was by barge. Also, the establishment of a railroad yard at the site and the provision of means for unloading and loading would have entailed heavy expense. The large barges available made it possible, in most cases, to lift the steel directly into place in the structure.

Barges were anchored under the erection derrick or traveler, and were spotted in position by a tug and held by wire-rope anchor lines fastened to heavy concrete anchors. Each barge was held by one, and sometimes by two upstream anchors, and either one or two downstream anchors, the latter to prevent it from whipping around in the current. The use of manila anchor lines had to be discontinued, as the excessive silt in the water quickly caused the strands to chafe and cut.

The U.S. Engineer Office allowed the closure of all but one of the navigable channels. The barge anchored in that channel had two lines connecting it to the work barge at the foot of the pier. By hauling in on these lines and slacking off on the anchor lines, the barge could be moved in to the pier quickly, without using a tug.

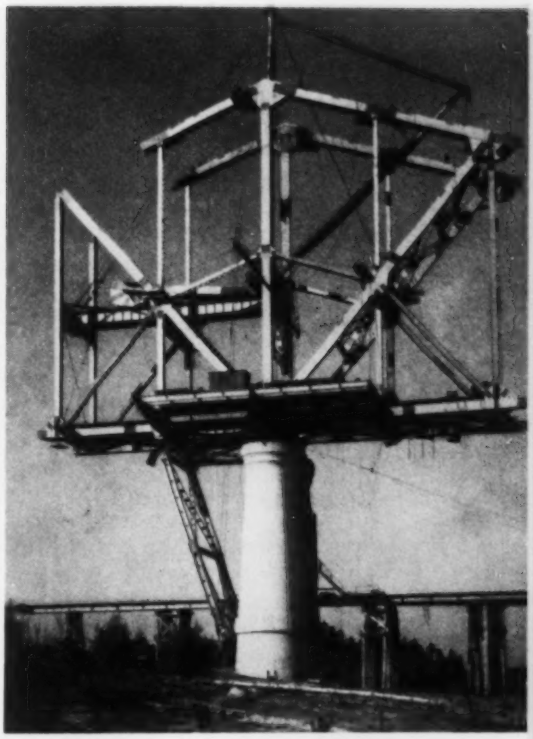
Pier 5, on the west side, is on dry land except at the higher river stages. To make the west anchor span between Piers 5 and 6 accessible, a timber dock approximately 104 by 133 ft in plan was constructed on the west shore, just north of the bridge, and far enough out so that barges could come alongside at the lowest stages. A stiffleg derrick was mounted just north of the dock and so located that it covered the entire dock area. The elevation of the dock was kept at 40 ft on the assumption, or hope, that no higher river stage would be encountered that season. Actually the maximum height was El. 38.9, early in April 1939.

From the dock a curved timber trestle was con-



COMPLETED BRIDGE OVER THE MISSISSIPPI AT BATON ROUGE

Clearance 65 Ft Over High Water. Note Highway Decks Cantilevered Out on Both Sides of Trusses



Erecting Steel at Pier 5—Part of Second Operation

Falsework Bent Takes Either Tension or Compression. Trestle Through Pier Brings Materials from Barge Dock

structed running back to and through the opening in Pier 5, and continuing on the center line of the bridge west across the levee and to Pier 6. Another tangent portion of trestle extended east of Pier 5 to a point where water deep enough to float a barge was encountered. All steel for the west anchor arm was unloaded from barges at the dock and hauled out over this trestle on flat cars running on a standard-gage railroad track. The same was true for all steel east of Pier 5 that could not be picked directly from barges. The dock also served as a small storage yard for miscellaneous supplies and equipment and for some steel members which could not be shipped in proper sequence.

Steel for the east anchor arm, also partly over dry land, was hoisted directly from the barges to the deck by one erection derrick and run back over the railroad track to the other derrick.

GUY DERRICKS REPLACE A-FRAMES IN RECENT PRACTICE; STIFFLEGS REPLACE GUYS AT BATON ROUGE

After the method of shipping and handling the steel was decided, the actual erection equipment had to be selected. Practically every conceivable type of derrick or traveler has been used in the erection of large bridges. Up to ten years ago, a stiffleg or A-frame derrick, mounted on a platform, with either skids, rollers, or actual wheels, was the standard bridge traveler. About 1929 one of the large fabricators and erectors started the use of guy derricks in bridge erection. This type has the advantage of a long, relatively light boom of large capacity, because of the long mast employed. It is usually much lighter for the same capacity than any other type and the boom has an unrestricted working area of 360°. Its disadvantages are the many guys required, the difficulty of locating suitable guy anchorages on a bridge, and the flexibility of the guys. On a narrow bridge, the side guys must be correspondingly steep with a consequent reduction in derrick capacity. One way of overcoming this is the use of projecting outrigger beams or "jiggersticks" to which to fasten the side guys, but these must be removed and re-erected each time the derrick is moved. Also, the forward guys are difficult to maintain unless forward outrigger beams are used. The first attempts to use guy derricks on bridges involved a number of serious accidents and their use is still by no means general. It is usually very difficult and dangerous to get them set up and started working.

On the Baton Rouge Bridge a novel adaptation of the guy derrick was used, perhaps for the first time. After the derrick was set up and the first truss members erected, all the mast guys were replaced by two stifflegs running from the top of the mast down onto and fastened to the top chord of the trusses. This provided in effect a huge stiffleg derrick with a mast 105 ft high, the truss members already erected acting as a part of it. By proper design and proportioning it was still possible for the boom to turn completely around and under these stifflegs. This gave all the advantages of both types of derricks without the usual disadvantages.

To start erection, the 95-ft boom of one derrick was first erected in the recess in the pier shaft just above high-water level, and guyed off from the top of the pier, thus making what is known as a Chicago boom. This boom first erected an inclined falsework bent supported on the pier itself, with the upper end tied back to the top of the pier, then a temporary working platform supported on top of the pier and on the bent. The boom was supported on a special frame which was raised or jumped to near the top of the pier, carrying the boom up with it, still guyed off to the pier top. In this position it erected the 105-ft mast on the platform as a base, guying it off to the platform beams. The side guys were connected to outrigger beams supported on the platform. The mast then erected the boom, pinning it off to the mast heel, and thus the first guy derrick was ready to start work. Three panels of truss could be erected from this position, but only for half the 124-ft depth of the truss at the piers. To enable the derrick to reach the topmost members over the piers, two panels of temporary floor were erected at the mid-height of the trusses, and the derrick was jumped up onto this floor.

Each of these derricks was operated by a 100-hp 3- or 4-drum steam hoisting engine located on a barge anchored to the pier. As the travelers moved away from the pier, the lead lines were run up and out to them through special sheave boxes in the floor just above the barge. Also located on the engine barges were three fuel-oil compressors which furnished air for riveting and for air hoists and other equipment. The traveler derricks were revolved or swung by small, air-operated, two-spool engines mounted on the traveler platform. Automatic air-operated bolt machines were used for fitting up joints and splices instead of the usual forked hand wrenches. Some of the rivet heating forges were connected to the air line instead of to the customary hand-operated forge fan. Since work was carried on simultaneously at two

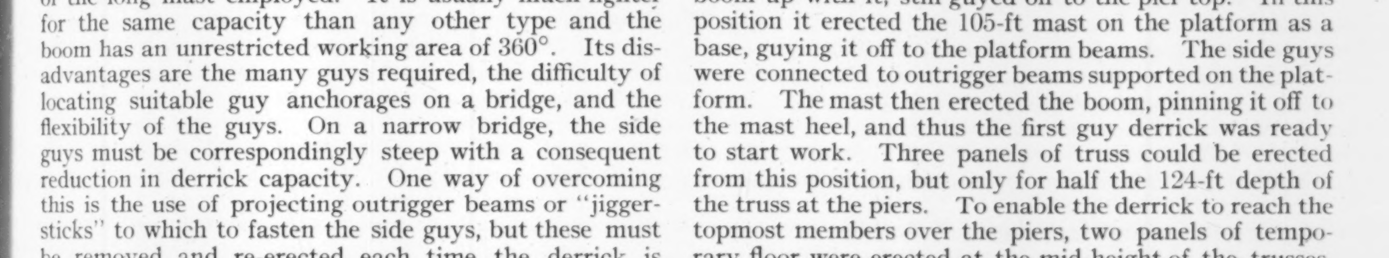
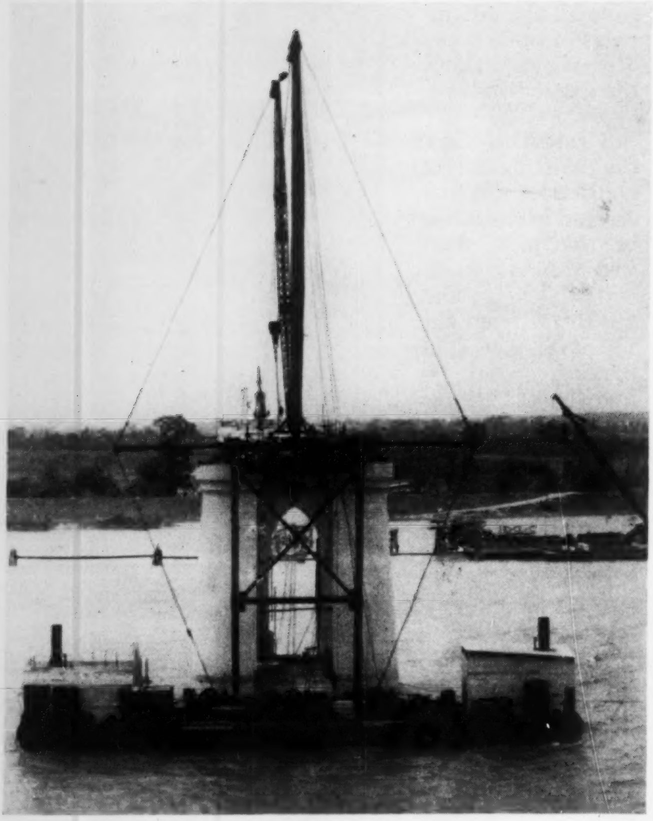


Fig. 1. At Site of Baton Rouge Bridge Soft River Bed Precluded Safe Use of Piling Falsework

Trusses Were 124 Ft Deep at the Piers



GUY DERRICK READY FOR START ON PIER 4

"Jigger-Sticks" Anchor Mast Laterally; Engine Barge in Foreground Permits Supply of Fuel and Water at River Level; There Are Six Electric Lights at Each Drum for Signaling

piers, two complete sets of the equipment enumerated were required, including two engine barges, each carrying identical equipment, that is, two steam hoisting engines and three fuel-oil compressors, together with various fuel and water tanks.

Starting erection on an intermediate pier of a bridge and building both ways by cantilevering is not an unusual procedure. The original time schedule for completion of the Baton Rouge piers was such that Piers 3 and 4 were expected to be finished first, and steel erection had to start there to take full advantage of the working time allowed under the contract. This also fitted in well with barge transportation, and double cantilevering was therefore decided upon.

FALSEWORK BENT SUPPORTED ON PIER CAISSON

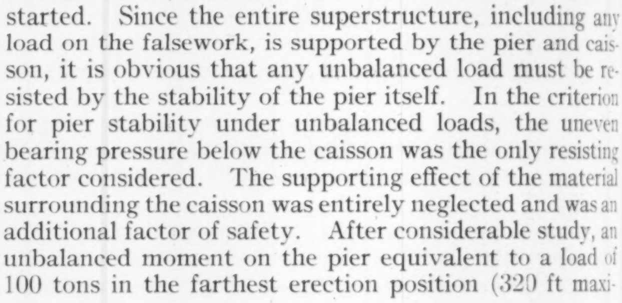
In this method of erection a falsework bent is ordinarily driven adjacent to the pier, and the columns of the bent, with the pier, form a platform on which to build. However, adjacent to Piers 3 and 4 the deepest water in the river was encountered—70 ft at low water at Pier 3 and 46 ft at Pier 4. During construction at least a 30-ft river stage was to be expected, which would give 100 ft of water at Pier 3 together with a swift current. With a soft mud bottom, subject to continual scour, it was impossible to drive a safe pile foundation.

A falsework bent had to be used, however, and the logical place to support it was on the caisson supporting the pier shaft itself. A steel anchorage was built into the 12-ft-thick concrete block forming the top of the caisson at El. −25, and located 16 ft 7 in. out from the center of the pier. This anchorage supported two pin-connected steel columns running up beside the pier shaft to El. +30, at which point they were braced by pin-connected struts embedded in the pier. All this was erected by the pier contractor at the time each pier was built, and is referred to as the lower falsework bent.

The upper falsework bent was supported on the common pin at El. +30 and inclined so that the top came directly under the first truss panel point 40 ft from the center of the pier. A short, adjustable, pin-connected link, containing a 500-ton hydraulic jack, supported the bottom chord on top of each falsework column. This provided for controlling the rotation of the balanced structure during closure with the adjacent span, as well as weighing the reaction on the falsework, which could be done only when the load was in compression. Using the bent in tension allowed for unbalanced load in either direction without the need for a second bent on the opposite side of the pier. Each falsework column was made up of three I-beams forming a compound H-section, and the beams themselves, as far as possible, were designed to be cut apart and refabricated as permanent stringers in the highway floor.

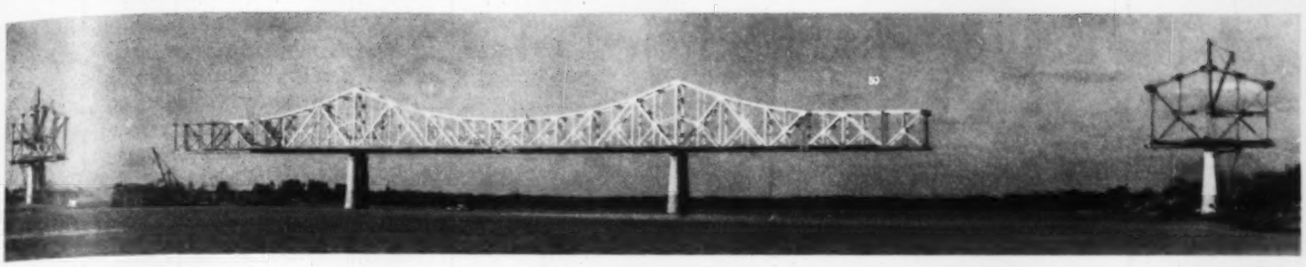
Elevation 30 was selected for the pin connection in the belief that the upper bent would be erected before the spring flood attained that stage, but the river won. At both Piers 3 and 4 the pins had to be driven under water, 3 ft deep at Pier 3 and over 8 ft deep at Pier 4. This was done by supporting the pins in driving position on a special framework attached to the upper falsework column. This framework was carefully lowered into place, and the pin was driven by pulling it into the pin holes with a wire cable. A diver made sure that the operation was correctly performed.

When both derricks had been erected, facing in opposite directions, true balanced cantilever work could be started. Since the entire superstructure, including any load on the falsework, is supported by the pier and caisson, it is obvious that any unbalanced load must be resisted by the stability of the pier itself. In the criterion for pier stability under unbalanced loads, the uneven bearing pressure below the caisson was the only resisting factor considered. The supporting effect of the material surrounding the caisson was entirely neglected and was an additional factor of safety. After considerable study, an unbalanced moment on the pier equivalent to a load of 100 tons in the farthest erection position (320 ft maximum) was assumed. This together with a 20-lb wind pressure acting on the pier and superstructure produced an excess toe pressure of about 2,900 lb per sq ft in the worst case, but both it and the maximum total pressure were less than for the worst loading condition assumed



BALANCED CANTILEVERING STARTED AT PIERS 4 AND 3—GUY DERRICK JUMPED TO HIGH POSITION

Bottom Chord Has Adjustable Pin Connection to Falsework Bent Through 500-Ton Jack



"Second Operation" Begins in Same Way as First

for the design of the completed structure. In computing these pressures the effect of buoyancy on the submerged portion of the pier was considered, also a skin friction of 500 lb per sq ft on the sides of the embedded caisson.

During erection it was constantly necessary to maintain the unbalanced load within the limit decided upon. To help in this and to allow each erection derrick the greatest possible freedom, a balance-car was used on the bridge deck. This was an ordinary 40-ft railroad flat car loaded with a truss chord and some rails to bring its weight up to 75 tons. It could be moved the entire length of the erected structure behind the two travelers. If for any reason one derrick reached the limit of its permissible erection, so that it would otherwise have to wait for the other derrick to catch up, the balance car could be moved out toward the second derrick, thus permitting the first derrick to continue its work.

JACKING FRAME USED IN MAKING CLOSURE

Engineers and laymen alike often ask how temperature changes and inaccuracies in fabrication and pier location are overcome in closing a continuous structure erected from two adjacent piers. Two types of closure problem were encountered at Baton Rouge. Between Piers 3 and 4 the trusses are truly continuous, while between Piers 2 and 3, and between Piers 4 and 5, there are two cantilever arms supporting a suspended span between them. The trusses are discontinuous in the panel at the ends of this suspended span but were made temporarily continuous during erection to permit cantilevering.

The answer to the question is that the aim is not to make the two ends meet exactly, but rather to make them miss. In the case of the continuous structure between Piers 3 and 4, the span on Pier 4, which is on a rocker shoe, had to be fixed in position during erection. This was done by temporarily locking the upper and lower shoes together, with the rockers in between. The locked position was chosen so that regardless of temperature and assumed inaccuracies, the ends of the two spans would still be too far apart when the closing chords were erected. To allow for a maximum temperature of 120 F, possible errors of an inch in fabrication and pier location, and a half inch or so to spare, one span was drawn back 5 in. When the center bottom chord was ready for closing in August 1939, it was found to be about $2^{1}/_{4}$ in. too short.

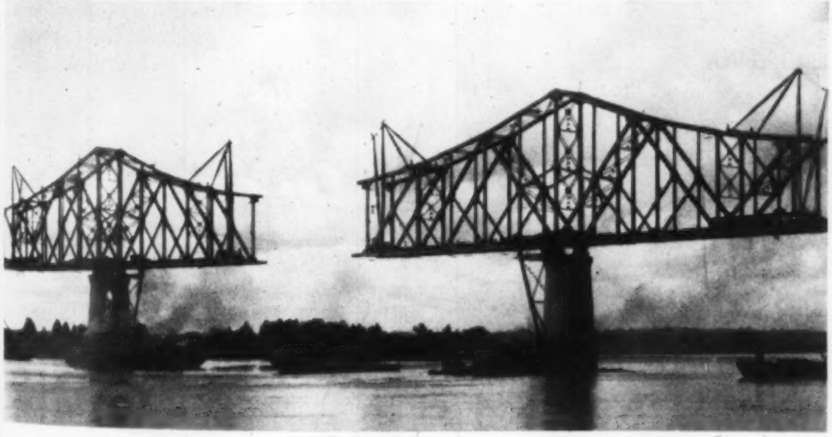
With all closing truss members in place, a specially designed jacking frame was erected over the still-open bottom-chord joint in each truss, bolted to each of the adjacent ends, and wedged tight. The rocker shoe at Pier 4 was then freed so that the rockers could function, and the span was pulled together by jacking the frame at the center until the bottom chords could be fitted together. The jacking force required was about 120 tons per truss—well within the capacity of the two 100-ton hydraulic jacks provided in each frame.

The two halves of this span were purposely erected somewhat higher than their true position by jacking at the two falsework bents adjacent to the piers. Thus when the bottom chords at mid span were closed, the top chords were still open about $1^{1}/_{2}$ in. Carrying the load on the jacks at the falsework bents and lowering them as required, rotated the two halves downward and brought the top chords to closure. Between the other piers, where the suspended spans were cantilevered, a slightly different procedure was used, but the general principle involved was the same.

The highway floor outside the trusses was not erected until the supporting span had been closed. Highway erection was assisted by a small traveler made of an A-frame derrick mounted on a platform which could be rolled along over the highway stringers. Power was supplied by a small gasoline hoist mounted on the traveler platform. Three of these small derricks were used, but two performed all the actual erection.

It is believed that the method of erection adopted for this structure was safe and economical for the existing conditions. It can be used, however, only where the supporting piers are capable of resisting reasonable overturning moments from unbalanced erection loads, and also from possible unbalanced wind loads.

The bridge was designed, and is owned and operated, by the Louisiana Highway Commission as a toll-free structure. The Louisiana and Arkansas Railroad Company pays the state $10,000 a month as rental for the single track. The Bureau of Public Roads, now the U.S. Public Roads Administration, aided in the financing of the project and reviewed and approved designs and details. All the accompanying photographs were taken by the writer.



Stifflegs Brace Mast to Top Chord, Replacing Guys
Material Barges Anchored Under Erection Derrick; 75-Ton Loaded Freight Car Rides Truss for Balance

Esthetic Responsibilities of the Engineer

By Harold M. Lewis, M. Am. Soc. C.E.

Chief Engineer and Planning Officer, Regional Plan Association, Inc., New York, N.Y.

The prevalence of ugliness around us tends to dull our imagination until we are deceived into viewing minor improvements with unwarranted pride. To avoid these fallacies we must stir ourselves to look across geographical boundaries and into the work of other generations—recognize the need for formal study. Some of the more recent industrial buildings, power plants, sewage works, show that vast improvements over the accustomed forms are possible if the engineer insists upon proportionate attention to appearance, as Mr. Lewis advocates in this paper, which was originally presented before a general session of the Society's Fall Meeting at Cincinnati.

By the esthetic responsibility of the engineer is meant in this discussion his responsibility for the appearance of the structures he designs—in themselves and in relation to their natural setting and to adjoining structures. The question under discussion is: To what extent should the engineer consider this matter of appearance? And should he not go further and see to it that his structures are as pleasing to look at as they are efficient in serving the special purposes for which they are designed? It should be recognized at the start that the success of the engineer's efforts in this direction will depend to a large degree on the extent of his cooperation with those other professions or specialists that deal more directly with the realm of art.

Many of the structures designed by the engineer are beneath the ground and are not seen by the public. For example, in the design of a sewerage system, water distribution system, foundation for a building, power station, or other heavy structure, esthetics can have little direct relation to the project, but even in such cases the engineer may be responsible for leaving serious scars on the surface of the earth which might have been avoided if he had fully realized his esthetic duty.

The responsibility of getting the engineer to give proper consideration to esthetics may be divided between the educator, the employer or supervisor, and the individual engineer himself.

Let us take up first the extent to which the educator, as represented by the engineering college or university, can or should attempt to impress upon the student his esthetic duty. This question is related to that of the amount of cultural education that should be included in an engineering course, but involves only a part of the latter question, as there are many other forms of culture than those under discussion here. A proper consideration of the appearance of structures and their relation to adjoining ones would of course be promoted by a broad cultural education in the humanities—art, philosophy, literature, languages, economics, music—but could be achieved without including this whole field.

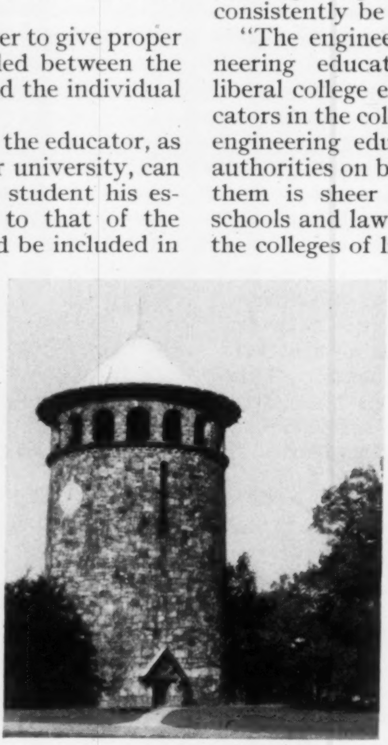
Dugald C. Jackson, M. Am. Soc. C.E., in his report on "Present Status and Trends of Engineering Education in the United States" (prepared for the Committee on Engineering Schools of the Engineers' Council for Professional Development, 1939) stated that "Every four-year engineering curriculum should embody four principal groups of courses." The first three of these are in the fields of science, mechanics, and professional engineering. The fourth is described as follows:

"Subjects of a general humanistic or cultural nature, including English (unless adequate proficiency as determined by examination is required in lieu of work in course) and general economics."

D. B. Steinman, M. Am. Soc. C.E., in an article on "Pre-Engineering College Education" (*Journal of Engineering Education*, December 1939) stated that "the present education of engineers is lacking in the humanities, and the average engineering graduate is an illiterate in the fields of economics, philosophy, history, the arts, and the social sciences." He argued strongly for two or four years of study in a liberal arts college as a required preliminary to the ordinary four-year engineering course. He stated:

"I am not here discussing the relative values of liberal college education and engineering education. I submit, however, that a combination of the two is superior to either alone as a preparation for professional life work. If this principle is accepted—and I do not see how it can consistently be challenged—then my thesis is proved.

"The engineering education should be given by engineering educators in the engineering schools. The liberal college education should be given by college educators in the colleges of liberal arts and sciences. For the engineering educators to claim that they are the best authorities on both and that both should be entrusted to them is sheer egocentric presumption. The medical schools and law schools do not dream of competing with the colleges of liberal arts or of usurping their province."



A Water Tower That Perfectly Suits Its Setting

Structure in Rockford Park, Wilmington, Del., Is Operated Jointly by the Board of Park Commissioners and the Board of Water Commissioners, the Former Having Jurisdiction Over the Stone Structure and the Latter Over the 500,000-Gal Tank Encased Therein

Whether or not the engineering colleges may hereafter insist on two or more years of preliminary college work, attempt to incorporate similar work into a five-year or six-year engineering course, or hold to the ordinary four-year course open to high school graduates, is too large a question to try to answer here. However, the writer believes there are immediate steps which can be taken to improve the present standard four-year civil engineering course.

It should be possible to include in this course something on the principles of architecture, landscape architecture, and city planning. When the writer attended Rensselaer Polytechnic Institute this was not done there, and probably not in any other engineering school at that time. Now Rensselaer requires its civil engineering students, in their senior year, to take a course in architecture described as "an introduction to the principles of architecture, their historical development, and their application to the modern problems of bridge construction, housing, city planning, and industrial buildings, such as power plants and substations." I am not sure to what an extent similar courses are to be found in other civil engineering curricula, but I am sure that such a procedure will lay the groundwork for some appreciation by the civil engineering graduate of the appearance of structures and their relation to their surroundings.

Graduate schools, particularly those with evening classes, such as New York University, are establishing courses of similar character which are being taken by practicing engineers, among others, who are finding the experience a helpful one in broadening their interests and their sphere of usefulness.

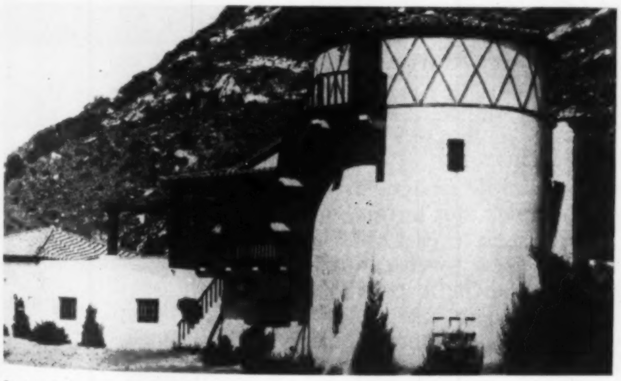
On the whole, however, one cannot expect the education of the average civil engineer to give him more than a general picture of his esthetic responsibilities—to merely expose him to this field hoping that he will absorb enough interest to lead him further under his own initiative.

EMPLOYER GROUP CAN STRESS THE IMPORTANCE OF APPEARANCE IN STRUCTURES

Employers or supervisors of civil engineers can help materially through their influence and control over subordinates on their technical staffs. Under "employers" are included the heads of private engineering, contracting, and consulting firms; under "supervisors," heads of engineering departments or staffs in public service organizations or private corporations.

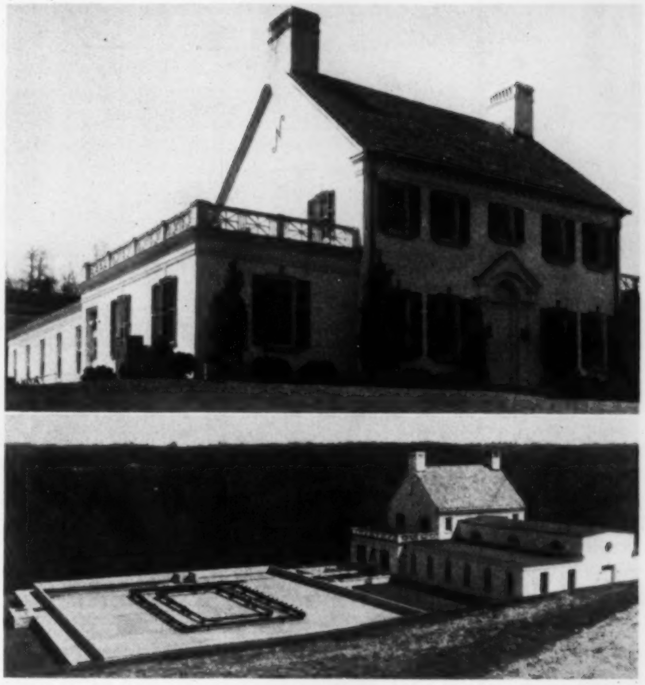
The employer group can, in relations with clients, stress the importance of the appearance of structures and urge that features to enhance this be included in projects for which they are responsible. In a similar way, the second group can point out the importance of esthetics to the executive heads of corporations or to the public officials to whom they report. It is believed that in many cases, though not unfortunately in all, these clients and executives will be receptive to such recommendations from their engineers and will recognize that any small increase in cost that may be entailed is well worth while.

In some cases such procedures may involve the employment, on public or private staffs, of junior architects or landscape architects, or, in the case of important projects arising only occasionally, the collaboration of engineers with members of these professions on a consulting basis. At first glance this may seem to propose that the engineer give up to these other professions some of the work he now handles, but this should be a matter of give and take, and there should be at least an equal number of occasions where it would be desirable for architects or landscape architects to employ or retain engineers on projects handled by them. If petty jealousies are not permitted, and if efficiency in obtaining the best possible result is always the goal, there will be plenty of work for all these related professions.



Courtesy Federal Works Agency

Unusual Decorative Treatment of Sewage Disposal Plant, Laguna Beach, Calif.



Courtesy Federal Works Agency

Filter Plant Designed to Pass Zoning Boards of a Highly Restricted Residential Neighborhood

Norwalk (Conn.) Water System Plant Has Settling Basins, Wash-Water Basins, and Filtered Water Storage Entirely Underground

The employer or supervisor can also exert a helpful influence over his subordinates by insisting that, in the preparation of detailed designs, they give proper regard to appearance and relation to adjoining structures. He should encourage those members of his staff who give evidence of a broad training and interest in this field.

In many ways the young engineer must follow closely the rules laid down by his superiors, but in a well-run office the initiative of the individual should always be encouraged. A young engineering graduate who has learned something of the principles of architecture and city planning in his engineering course may well be able to contribute to esthetics in the design of structures, if his superior is open minded enough to give him the opportunity. Benefits will accrue to both.

The major responsibility for educating the civil engineer to a proper appreciation of esthetics will probably continue to rest with the individual himself. Most of us will admit that the graduate engineer, if he is to be successful, should recognize that his education is not finished upon receipt of his diploma, and that it must be continued as a part of the practice of his profession, during which he will learn how to apply not only the knowledge he has obtained but the ability he has acquired to refine and expand that knowledge. If an engineer is to be successful in developing his esthetic sense, he must assume a responsibility for some self education in the appreciation of the artistic.

Back in the fifteenth century we find, in Leonardo da Vinci and Michelangelo, men who were both engineers and artists. The latter was perhaps considered more of an architect than an engineer, but he certainly was an outstanding structural designer and city planner of his day. In addition he gave posterity the "Last Judgment" and many other famous paintings and works of sculpture.

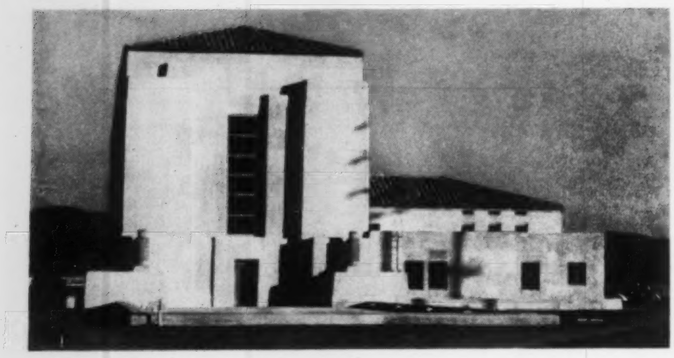


Photo by Metropolitan Water District of So. Calif.

A WHITE BUILDING WITH RED TILE ROOF SUITS ITS DESERT SURROUNDINGS

Hayfield Pumping Plant on Colorado River Aqueduct

Leonardo da Vinci's record is so remarkable that it must be mentioned in this connection. Known to most people as the creator of the "Mona Lisa" and the "Last Supper," he painted only as a diversion, his real interests being engineering and architecture. A temporary exhibit now at the Museum of Science and Industry in New York City shows copies of many of the original sketches for his inventions, and structures and models prepared from these. They demonstrate that Leonardo was an outstanding civil and mechanical engineer, architect, and student of anatomy. Among his inventions are such things as lift pumps, canal locks, excavating and hoisting machinery, a printing press, a coin-making machine, a horseless carriage, a flying machine (which failed to fly because of insufficient power), artillery, and a diving helmet. He designed military fortifications, churches, and other monumental buildings; he even prepared a plan for a model town with two levels of traffic—vehicles on the lower level and pedestrians above. He trained himself to take notes with one hand and write his conclusions simultaneously with the other and was able to write backwards and upside down. All this he accomplished in a life span of sixty-five years.

ESTHETICS AND PROFESSIONAL ADVANCEMENT

The young engineer cannot be expected to emulate such examples, although there are in our Society members who are proficient with the brush. All that is suggested is that he appreciate the importance of some general knowledge of art as an asset to him in advancement in his profession. He should look upon himself as having some common interests with the kindred professions of architecture and landscape architecture, although he should not expect to become an expert in either.

Probably one of the best ways to acquire a proper knowledge of esthetics and an appreciation of the effectiveness of cooperative effort between different professional groups is through active participation in some form of civic work. For example, an engineer who has served on his local planning commission will discover that he can make a real contribution toward civic improvement and will incidentally become a better engineer in the process.

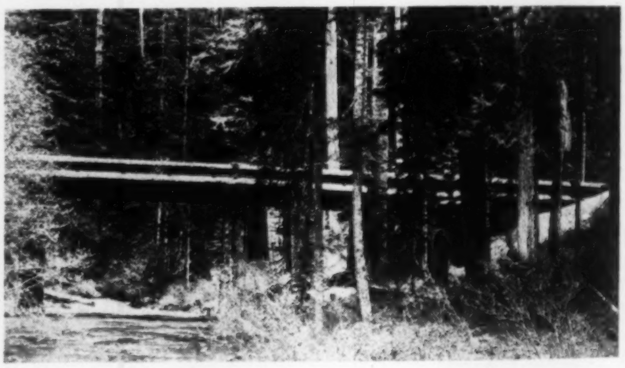
One way in which governmental agencies can help is through in-service training of their technical employees: Many federal, state, and municipal agencies have developed some form of in-service training during the past ten years. In general, the courses given are to acquaint non-technical workers in public service with their departmental duties, broadening their general and specialized knowledge and fitting them for promotion. Why should not engineers in the public service be given the opportunity to take courses in city planning, principles of architectural design, and other fields that would develop their sense of esthetic responsibility?

The states of New York and Virginia have been outstanding in the development of in-service training for municipal employees, in the first case through the Municipal Training Institute of New York State, promoted by the State Conference of Mayors, and in the second through the League of Virginia Municipalities. In neither state have in-service schools for engineers been established, on the theory that this group is prequalified by law.

Governmental agencies should see to it that their engineering departments are able to avail themselves of the services of architects and landscape architects, and in return that engineers can be employed in a similar way on architectural projects. Through the interchange of ideas that will result, the engineer will learn to appreciate his esthetic responsibilities and the architect and landscape architect will acquire a better appreciation of what sound engineering can contribute to structural design, the effective use of materials, and efficiency of operation.

It seems more difficult to bring about such an arrangement in public than in private construction. In some cases, civil service regulations make it difficult for a technical department to employ consultants in allied fields at fees comparable with those of private practice. In other cases, such an arrangement is specially provided for. For example, the Federal Civil Service Act provides for the retention of outside architectural or engineering firms, corporations, or individuals by the Department of War, the Navy Department, the National Park Service of the Department of the Interior, and the Public Buildings Administration of the Federal Works Agency. A similar provision for some other federal agencies that do not now have such rights would seem desirable.

In some types of structures, such as a suspension or arch bridge, an artistic appearance is almost sure to result from a simple design, as the structure will then follow natural lines and nature seems to be inherently artistic. In other structures a blind following of efficient engineering design may well result in a product that is ugly and disregards esthetic principles. The danger of a lack of coordination in design has been well expressed by the well-known architect, Harvey Wiley Corbett of New York City, who has stated that, if it were not for the engineers, the large buildings designed by architects would fall down, and if it were not for the architects, those designed by engineers would be pulled down.



Courtesy U.S. Public Roads Administration

CONGER CREEK LOG STRINGER BRIDGE IN MOUNT RAINIER NATIONAL PARK, WASHINGTON

Material Used Fits Local Conditions and Shows That Functional Line and Form, Rather Than Applied Decoration, Result in a Beautiful and Serviceable Structure

Shelter for Civilians in Modern Warfare

Detailed Statistical Surveys Needed in Planning for Metropolitan Areas—Large Shelters Found Most Economical in British Study

By Joseph D. Lewin, Assoc. M. Am. Soc. C.E.
Consulting Engineer, New York, N.Y.

As yet American experience in shelter construction techniques has not been extensive. Until it becomes more so and until American tests of materials and explosives become available, we can only be guided by results of European experience. Mr. Lewin has been following the European reports and developments closely for several years and frankly bases the present discussion on what he has read. Existing knowledge of cause and effect in connection with loss of life in shelters seems woefully inadequate. Balancing cost and time against the uncertain probability of attack cannot be easy. But the material presented may prove valuable in suggesting how to undertake the solution of the problem.

AERIAL warfare has introduced new factors in ballistics and in protective construction. First, the amount of explosives per unit weight of bomb is greater than that in shells. A 340-mm shell weighs about 1,000 lb and contains 60 lb of explosives, but a 1,000-lb aerial bomb is charged with over 500 lb of explosives. Secondly, the radius of attack has increased from 25 to 40 miles for a gun to from 500 to 1,000 miles for aircraft. The higher destructive force of each projectile plus the larger radius of action make possible "total warfare," with its aim of destroying industries, public utilities, and centers of concentrated population. Hence protection for civilians must be provided by engineers. As such problems have confronted European countries for years, it is logical that many new theories should have originated there.

The civil war in Spain demonstrated that underground refuges give a certain security to the population (for example, Barcelona) but also indicated the possibility of the total annihilation of unprotected communities (as at Guernica). The British have found that protection must be planned far ahead and cannot be assured at short notice. The war scare during the Munich conference sent the people hastening to convert parks, squares, backyards, in fact every square foot of open ground, into trenches. Today, those trenches are abandoned and full of water. Next came the portable shelter (Anderson hut). But despite all the persuasion of the authorities, the population prefers to travel for miles to a deep, secure, and overcrowded shelter than to take the chance, in an Anderson shelter, of being blown to the roof of an adjacent building.

Although the size of bombs varies from 50 to 4,000 lb and more, there are basically only four types:

Incendiary bomb (only 2 to 5 lb) develops highest temperature (2,000 C)
Percussion bomb has largest blasting power but little penetration
General-purpose bomb has penetration and blasting power (Table I)
Armor-piercing bomb has highest penetration capacity

If released during a horizontal flight, the projectile has an initial horizontal velocity of the plane. Gravity gradually deflects the bomb, and during its parabolic fall it gains momentum until the friction forces counteract the gravity forces. From then on, the velocity is nearly constant, and the bomb strikes at an angle of 15 to 30° with the vertical.

To increase the final velocity and to make the fall steeper, a vertical initial velocity may be introduced by releasing the bomb during a vertical dive (say at 400 ft per sec). This also increases the accuracy of bombing. For example, at 10,000 ft an error of 6 miles per hr in estimating horizontal speed would result in an error of 250 ft on the ground.

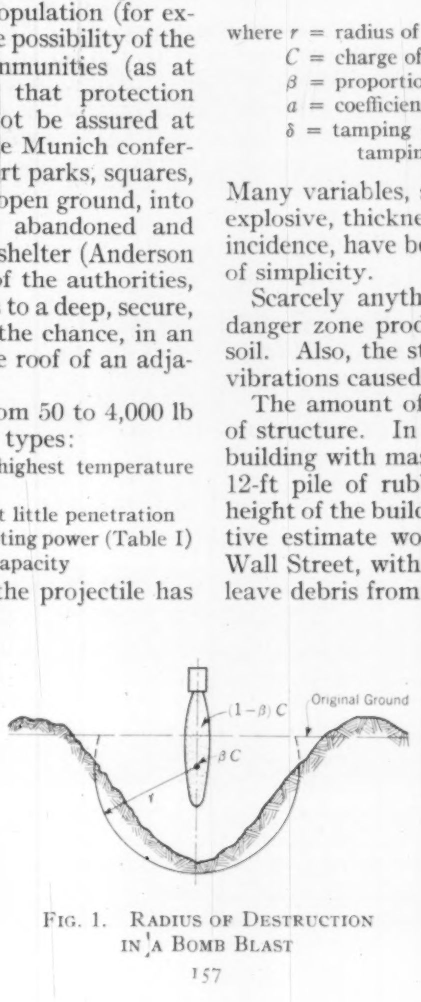


Fig. 1. Radius of Destruction in A Bomb Blast

The blasting effect, although not well known at present, can be estimated to some degree. The pressure on the bomb shell is estimated at between 100 and 650 tons per sq in. The pressure drops rapidly with the distance from the center of the blast. For a 1,000-lb bomb, the air pressure is still fatal 230 ft away. Beyond 400 ft from the blast, an unprotected individual is relatively safe.

In the ground the destructive effects of a blast are limited to a certain zone whose radius can be computed. The following formula is given as a compromise between workability and accuracy (Fig. 1):

$$r = \sqrt[3]{\frac{\beta C}{a\delta}}$$

where r = radius of destruction, in meters
C = charge of explosive in kilograms
β = proportion of charge underground
a = coefficient of ground (for earth, 0.7)
δ = tamping coefficient (for good tamping, 1.0; for poor tamping, 3.5)

Many variables, such as depth of penetration, nature of explosive, thickness of shell, shell material, and angle of incidence, have been deliberately neglected for the sake of simplicity.

Scarcely anything is known as to the extent of the danger zone produced by a shock transmitted through soil. Also, the structural damages from high-frequency vibrations caused by the blast are not known.

The amount of debris of course depends on the type of structure. In Warsaw, the collapse of a 4 or 5-story building with masonry bearing-walls resulted in a 10 to 12-ft pile of rubble, or a heap about one-quarter the height of the building. For frame structures, a conservative estimate would be from one-eighth to one-tenth. Wall Street, with its 30-story buildings, would probably leave debris from 30 to 40 ft deep.

Although a shelter policy is influenced by various considerations, such as the funds to be diverted to active or passive defense, probability of attack, locality, time of construction, materials available, and accessibility and size of shelter, some common denominator is required in order to compare the relative values of various types of shelters. Tecton, in planning for the protection of the Borough of Finsbury, London (*Planned A.R.P.*, London, 1939), accepts the suggestion

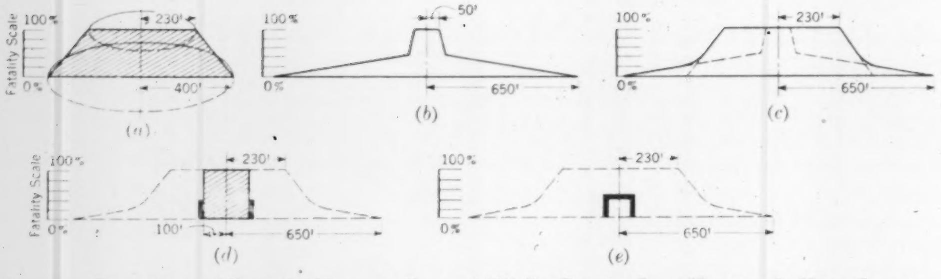


FIG. 2. CONCEPT OF "DANGER VOLUMES" FOR 1,000-LB BOMB—LOW VOLUME IS HIGH SAFETY (a) Blasting May Be Fatal to Man in Open if Bomb Falls Within 400 Ft, Certainly So Up to 230 Ft; (b) Certainty of Fatality from Fragmentation of Same Bomb Less, Possible Radius Greater; (c) Cross Section of Combined Danger Volume; (d) Infinitely Strong Wall, No Roof, No Danger from Bomb Outside Wall; (e) Roof Plus Wall, 100% Safe, Danger Volume Zero

of O. N. Arup to use the "danger volume" as the yardstick. The value of this yardstick is open to question, but it is the only one available.

The danger volume is a calculated quantity which may be conceived as indicating the "amount of danger" against which a civilian in the shelter is not protected. A shelter with a low danger volume is therefore the one to be preferred in a scuffle.

The figure is arrived at in the following way. For the worst case, no shelter at all, assume a person standing unprotected (Fig. 2a). A 1,000-lb bomb exploding anywhere within a radius of 230 ft is claimed to be fatal, therefore the danger within this radius may be said to be 100%. If the blast occurs in a zone beyond 400 ft, the person (with good luck) will not be affected, and the danger is said to be 0%. Between 100% and 0%, a linear distribution of danger is assumed. The shaded area is the cross section of a hypothetical volume around the person, and it is this quantity which is called the "danger volume" from a 1,000-lb bomb blast. Similarly, "danger volume" for splinter action (Fig. 2b) and combined splinter and blast action (Fig. 2c) can be computed. Furthermore, danger volumes for various types and sizes of bombs might be devised.

Now suppose that the person is surrounded by an infinitely strong wall (Fig. 2d). He is protected from all danger outside the wall, and is vulnerable only to bombs exploding inside. If the surrounding wall has a 10-ft radius, the area inside the wall is 100 times smaller than if the radius is 100 ft, and the person should be 100 times safer. Finally, if the individual is surrounded by both the wall and an infinitely strong roof (Fig. 2e), he is safe against any bomb.

TABLE I. BOMB CHARACTERISTICS

Obtained in Part from the British Air Raid Precautions Handbook No. 5, *Structural Defense*

	WEIGHT OF BOMB, IN LB						
	50	110	220	550	1,100	2,200	4,000
Type of shell casing	Medium	Heavy	Medium	Medium heavy	Heavy	Medium	Medium
Diameter of bomb (in.)	5	7	10	12	12	21.5	25.5
Sectional weight (lb per sq in.)	2.5	2.9	2.8	4.9	9.7	6.1	7.8
Appr. max. velocity (ft per sec)	500	600	700	800	1,000	1,200	1,500
Appr. max. penetration (ft):							
Soft clay	11	16	20	37	92	72	95
Earth	7	10	12	24	59	44	62
Sandy soil	6.5	9	10	20	50	32	47
Firm gravel	4	6	7	14	35	26	37
Timber (oak, beech)	3	5	6	12	33	25	47
Bricks	3.5	4	4.5	9	25	20	32
Hard limestone	1	1.5	2	3	8	5.5	8.5
Rein. concrete (2,800 lb)	0.8	1	1	1.5	6	4.5	7.5
Rein. concrete (3,200 lb)	0.7	0.7	0.8	0.9	4	3	5
Rein. concrete (5,700 lb)	0.5	0.5	0.6	0.7	3	2	3.5

Since infinitely strong walls and roofs are not always possible, Arup computes relative values of dangerousness for different strengths of structure. The complete parameter of danger to the individual is obtained by dividing the danger volume of a given shelter for a certain bomb by the weight of that bomb.

The question arises as to what size of bomb should be used as the basis for the calculations. Tecton arbitrarily assumes that a bomber load consists of: 100-lb bombs, 40%; 220-lb, 30%; 550-lb, 20%; 1,650-lb, 8%; and 2,200-lb, 2%. In general, this statistical method of probability may be questioned. The large number of direct hits on shelters is astonishing. Whether a "relative safety" can be assumed, or whether a shelter should be considered simply as "safe" or "unsafe" is uncertain, for if a relatively safe shelter is hit, the persons in it will certainly become 100% dead. Furthermore, the assumption of various bomb sizes is arbitrary, and no consideration has been given to the bombing pattern, density of bombs, or the possibility of simultaneous blasts from two or several bombs. No provision is made for comparing the sizes of exposed surfaces or the density of shelters in an area. Obviously, for the same area, the chances of a direct hit are increased with the number of shelters, whereas the total fatalities might be decreased. Finally, the location of the shelter is completely neglected. A shelter in a residential section is safer than one between a drydock and a power house, or one in the vicinity of a munition dump or in front of a tall building.

The requirements of shelters define their location. Since a shelter must accommodate the population in the vicinity, it must be easily accessible. On the assumption that sheltering will be of short duration, and to minimize interruptions to normal life, a warning period of 7.5 to 10 minutes is used in England. The usefulness of a shelter will then be limited by the distance its prospective patrons can cover during the warning period. Considering time lost for dressing, getting to the street, and so forth, this distance is estimated to be about 900 ft by daylight and 450 ft in the dark. A shelter with a radius of 300 ft therefore can only serve an area of less than 2 acres. Thus, for a population density of 100,000 per sq mile, a shelter should accommodate 250 persons.

This connection between the area served by a shelter and the warning period is of course debatable. There are several reasons. Civilian behavior during a raid is uncertain. Many may prefer to run another 100 yd to a safer shelter, taking chances with the planes overhead. Also, basements of adjacent buildings may be connected, or other steps taken to provide comparatively safe access to a shelter, thus increasing its effective radius. Moreover, the basic assumption of the necessity for warnings is not entirely upheld by current experience. Thousands begin moving to the safest shelters hours before the first alarm sounds, and may remain in them long after the "all-clear" siren. The shelter is therefore an overnight refuge, should be treated as such, and should not be limited to serve a small area. Of course, some less elaborate shelter should be accessible for day attacks. Similarly, the location of a shelter is limited by safety requirements. No shelter should be situated near dangerous installations such as water mains, sewers, power lines, gas lines, boilers, or water, gas, gasoline, or explosive storage.

It is clear that the location of shelters cannot be picked at random, but should be based on a complete survey of the community. Such a survey should include information on the density of population at night and in the daytime, topography, subsoil conditions, ground water, heights and structural types of buildings, zones of important centers of manufacturing and other objects of bombardment, open spaces available, location of main utilities and underground developments, transportation, and other information that would have a direct bearing on the choice of the proper type of shelter.

Determination of shelter size is of crucial importance and affects the entire plan of protection. Advocates of large focal shelters presume that the people arriving first will proceed to the furthest point in an orderly manner, and that the shelter will be filled progressively. But the influx of people is not uniform; it increases steadily. If all start at the warning signal, 21% may be expected to reach the shelter during the last minute and 40% in the last two minutes—this for a shelter serving an area of 900-ft radius. The congestion may become more aggravated if the people living nearby fail to heed the signal immediately.

Although small shelters may be built by individuals at their own expense, large shelters must be constructed by municipalities with regular building equipment and skilled crews. Will the necessary materials, equipment, labor, supervision, and time be available during an emergency? This can be a decisive factor.

A large shelter has to be made much safer than a small one, since larger numbers are endangered. On the other hand, the total amount of work and materials for housing the population in small units is much higher than for protecting them in large centers. A reinforced concrete shelter for 12 people requires 7 cu yd per person; a shelter for 200 people requires only 2 cu yd per person.

It is not feasible to provide every small shelter with utilities and sanitary accommodations. These small shelters are also much inferior with respect to "relative safety." The cost of sheltering a person decreases with the increasing size of the shelter. Table II gives prices quoted by Tecton. Although they are based on conditions in England and although costs for large shelters may be underestimated, the relative significance of these figures is probably valid.

Shelter entrances are an important consideration. If the entrance is a ramp (not steeper than 1:8), about 20 men per minute can pass for each foot of width. Stairs have a smaller capacity. Ramps should be curved to limit possible casualties. Choice of entrance slope may also limit the depth of the shelter, and the necessary width of the entrance may decide the size of the shelter. The latter is particularly true if the occupancy depends on the warning period. As yet, little consideration has been given to the use of escalators or other mechanical means for speeding up the filling rate. Some arrangement of slides or chutes might be well worth study.

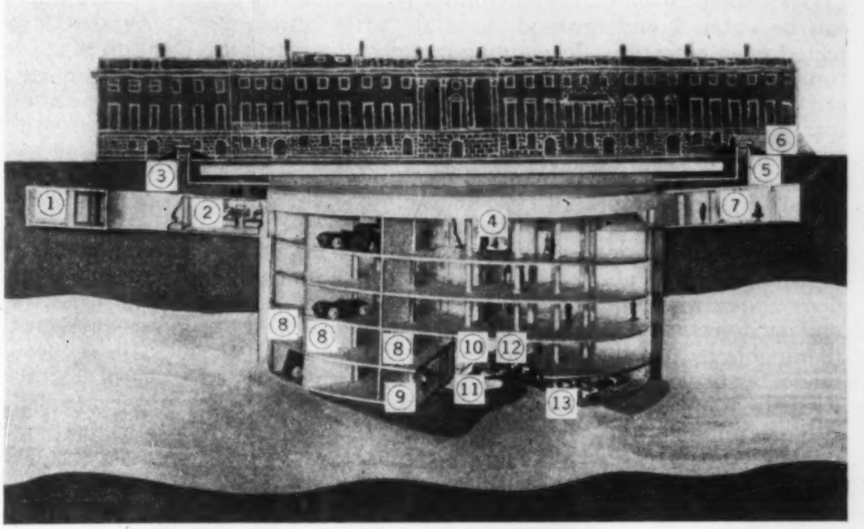
TABLE II. COMPARATIVE COSTS FOR VARIOUS TYPES OF PROTECTION

Based on Estimates by Tecton for Conditions in England, Allowing 6 Sq Ft per Person

	TYPE OF PROTECTION	COST PER PERSON, IN £	DANGER COEFFICIENT
A.	Trenches		
	British Government design, 50 ft long, 4 ft 8 in. wide, for 1,780 persons per acre, 6-in. concrete walls	4.80	42
	Circular trenches, 15-ft diameter, for 4,150 persons per acre, 6-in. concrete walls and roof	4.68	25
B.	Surface Shelters		
	Buildings, 25 ft long, 5 ft wide:		
	6-in. walls, 6-in. roof	3.3	39
	24-in. walls, 6-in. roof	5.6	25
	6-in. walls, 60-in. roof	7.05	9
	24-in. walls, 60-in. roof	10.75	3
C.	Bombproof Underground Shelters		
	Circular, 4-story, protected by bursting layer, 280 persons, safe against:		
	100-lb bomb	9.1	9.9
	1,000-lb bomb	15.95	0.2
	Same, protected by 15-ft earth layer, safe against:		
	100-lb bomb	7.25	5.4
	500-lb bomb	11.35	0.1
	Circular, as illustrated in Fig. 3, 7,600 persons, safe against:		
	100-lb bomb	4.0	59
	2,000-lb bomb	7.25	0.1

One or more emergency exits must be provided because the normal entrance may become blocked by debris.

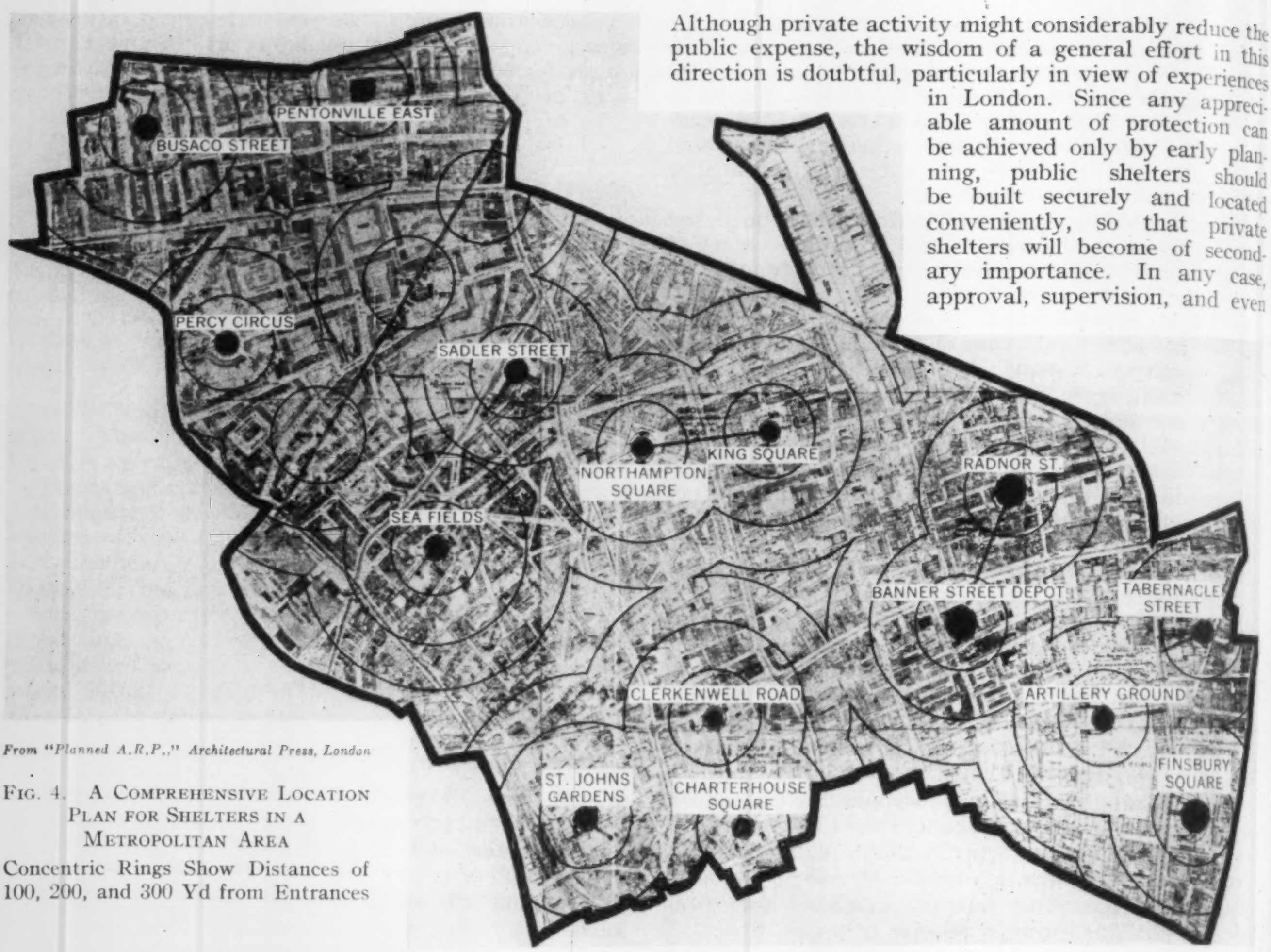
Shelters can be built on the surface, underground in new ground, or in basements. Surface shelters are more exposed but are more easily installed. They are not affected by ground-water conditions or underground utilities, but rather by the availability of open spaces. The protection afforded by such surface shelters (trench or hut type) is very limited. A normal house with windows protected affords more security than a light surface shelter. Advocates of multi-story reinforced-



From "Planned A.R.P.," Architectural Press, London

FIG. 3. SHELTER FOR 7,600 PERSONS DESIGNED FOR FINSBURY

(1) Entrance Ramp, (2) Air Lock and First-Aid Post, (3) Air Exhaust (Peace) or Intake (War), (4) Elevator for Garage Use in Peace, (5) Air Intake—War Emergency Only, (6) Street Entrance to Ramp, (7) Ramp, (8) Baffle Walls, (9) Storage, (10) Elevator Hoist, (11) Sump, (12) Ventilating and Drainage Pumps, (13) Poison Gas Filters



From "Planned A.R.P.," Architectural Press, London

FIG. 4. A COMPREHENSIVE LOCATION PLAN FOR SHELTERS IN A METROPOLITAN AREA

Concentric Rings Show Distances of 100, 200, and 300 Yd from Entrances

concrete surface structures overlook the fact that a large wall surface is exposed which is practically impossible to make bombproof, particularly if located between tall buildings.

Deep shelters afford the maximum protection. They can be entered underground, so that persons are protected even en route. Depending on subsoil conditions, tunnel or multi-story types are preferable (Fig. 3). They are easy to heat and to render gasproof. The cost per capita is low for the degree of security obtained. If time is pressing, cellars of one or two buildings in a block may be equipped as shelters. The decision should be based on such factors as type of building, amount of material needed, and possibility of gasproofing and heating. Such conversions may imply underpinning, pouring of new slabs above the existing ceiling, filling the floor above with sand or sandbags, relocation of valves and switches, pipes and conduits, and removal of inflammable material. The choice of cellar should not be made by private individuals but by authorities armed with the knowledge of thorough surveys.

Some publicity has been given to safety in the interior of skyscrapers. Except where buildings are closely spaced, the bomb strikes from the side as frequently as from the top, and the danger per square foot is the same on any floor. There is also uncertainty as to the behavior of a tall building if a row of columns is knocked out. Will the rigidity above redistribute the forces or will the building collapse?

The majority of the population will be dependent on shelters provided by the municipalities. Some apartment builders and private owners may build their own. Although private activity might considerably reduce the public expense, the wisdom of a general effort in this direction is doubtful, particularly in view of experiences in London. Since any appreciable amount of protection can be achieved only by early planning, public shelters should be built securely and located conveniently, so that private shelters will become of secondary importance. In any case, approval, supervision, and even operation of private shelters should be controlled by the authorities.

If public underground shelters are built in peacetime, it may be possible to combine them with other structures, to place them in subbasements of public buildings, to provide subways and tunnels for underground utilities, and to make entrances suitable to conversion from peace to shelter uses. There are many possibilities for the economic employment of such space in time of peace for storage, parking, or shop occupancy, as suggested in Fig. 3.

An outstanding example of an engineering approach to the problem of protecting a community of 135,000 is the plan for the Borough of Finsbury, previously referred to. The illustrations for the present discussion have been borrowed largely from this book. After extensive surveys, which included statistics, geology, transportation, construction methods, labor, and costs, 15 large deep shelters were proposed in the locations shown in Fig. 4. Also studied before this layout was recommended were the day and night population densities, distribution of businesses, heights of buildings, and locations of all utilities. As indicated, these shelters would provide complete safety for almost the entire borough. In some instances underground passages would connect pairs of shelters.

Probably no one type of shelter should be advocated as a standard, for local conditions will vary. The facts essential to any decision should be thoroughly explored before any choice is made. Certainly any new construction of utilities or buildings should be planned with an eye to the protection of civilians.

William Mulholland—Engineer, Pioneer, Raconteur

Part II. The Owens Valley Aqueduct and Later Work

By J. B. LIPPINCOTT

HONORARY MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, LOS ANGELES, CALIF.

THAT "truth is stranger than fiction" is well illustrated by the romantic life of William Mulholland. The first part of this biographical sketch, which appeared in the February issue, told how he came to this country from Ireland, started in water supply work in California in a characteristically picturesque way, and rapidly rose to be head of the Los Angeles City Water Company. This second part of the story begins with the proceedings accompanying the taking over of the private water company by the City. It describes Mulholland's work of initiating and constructing the Los Angeles Aqueduct, touches on his interest in the Colorado River project, and gives a general picture of his great contribution to water supply thought and progress in Southern California. It is a very human story of a very remarkable man.

MULHOLLAND'S connection with the Los Angeles City Water Company dated from 1878. Starting as a ditch tender, or *zanjero*, he had rapidly risen to be head of the company. In 1898 the franchise under which the company operated expired, but Mulholland continued to serve as manager through the three years of litigation that followed. With the purchase of the existing works by the City of Los Angeles in 1902, Mulholland was retained by the new ownership in his former capacity.

The franchise of the Water Company provided that at its termination the municipality must buy the plant at a fair price, to be determined if necessary by arbitration. Upon the termination of the franchise the property had become valuable and the Water Company resisted transferring it to the city. The annual gross revenue had risen to $425,000, and the distribution system contained 325 miles of pipe. The newspapers in the city were opposed to public ownership of the water works.

WILLIAM MULHOLLAND IN AQUEDUCT CONSTRUCTION DAYS

The franchise provided for three arbiters, one to be appointed by each party and the third to be selected by these two. James C. Kays was appointed by the city; Charles T. Healey by the water company; and George H. Mendell, M. Am. Soc. C.E., a retired Army engineer, was chosen as the third. To present its case to the arbiters the city employed a Board of Engineers composed of James D. Schuyler (known as Uncle Jimmy), M. Am. Soc. C.E., Arthur L. Adams, M. Am. Soc. C.E., A. H. Koebig, and the writer. Mulholland, as manager of the privately owned plant and engineer of the property, was called upon by the board for information.

As is frequently the case with people of fine memories, his records were not perfect. After the Board of Engineers had politely expressed the opinion that these records were not sufficient for a proper evaluation of the property, Mulholland asked, "What is it you want to know?"

Uncle Jimmy replied, "The thing we want is a complete list showing the length of pipe, its size, character, and age. We also want to know the number of gate valves and all about them, as well as [the number and position of] fire hydrants and all other structures connected with the water system."

"Get a map," said Mulholland, "and I will tell you." Thereupon a large-scale map of the city was spread out on a drafting table, and he proceeded to give from memory the size, kind, and age of the pipe in every one of the city streets, together with fittings. He also designated the gate valves and hydrants. The Board expressed surprise at his memory but stated that it did not feel an inventory made in this way was adequate.

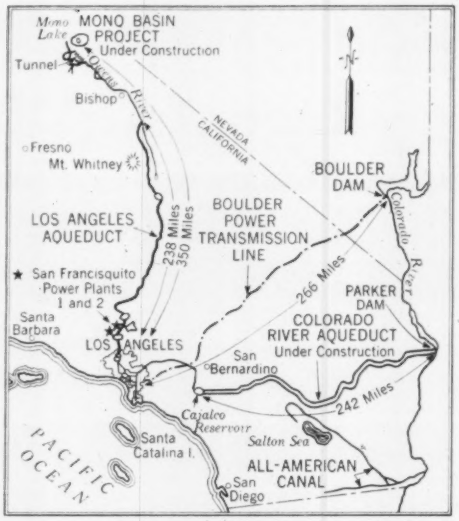
Therefore he was informed that in order to test the accuracy of this oral record the pipe should be exposed at various points throughout the city so that the Board of Engineers could inspect it. The Board indicated with red circles on a map of the city 200 places where it wished to make such inspection.

Mulholland was not in the least disturbed by this request; in fact he seemed rather pleased. He had the pipe dug up at the points designated, and the Board actually checked the type and condition of all pipe exposed. This inspection indicated that his memory was correct in every particular and the Board thereupon accepted the inventory of the pipe system of the city based on the memory of Mr. Mulholland.

The valuation placed on the system by this board was $997,621. The water company however claimed a valuation of $3,000,000. A compromise agreement was finally accomplished by Fred Eaton, ex-mayor of Los Angeles and a Member of the Society, for

$2,000,000 and on that basis the water works were acquired by the city in February 1902.

One of the anecdotes told about Mulholland concerns an incident that took place during the protracted litigation preceding the city's acquisition of the water system. One of the Water Company's attorneys had been cross-examining a witness at great and tiresome length. The attorney, reaching the limit of his repertoire, turned to Mulholland and whispered, "What else shall I ask him?" "Ask him where he got the red necktie he is wearing," Mulholland replied. The attorney with a troubled look thought this over and asked for an adjournment of court in order to learn what obscure line of thought was in Mulholland's mind. Mulholland in this way quietly accomplished his purpose of stopping the cross-examination.



LOS ANGELES WATER SUPPLY SYSTEMS AND MUNICIPAL TRANSMISSION LINE FROM HOOVER DAM

When the plant was transferred the municipality had the good judgment to include Mulholland and his staff in the bargain. Of the latter, Thomas Brooks, M. Am. Soc. C.E., the superintendent of distribution, Fred Fisher, mechanical engineer, L. M. Anderson, the auditor, and George Read, head of the meter department, were until lately active members of the organization.

INITIATION OF OWENS VALLEY PROJECT

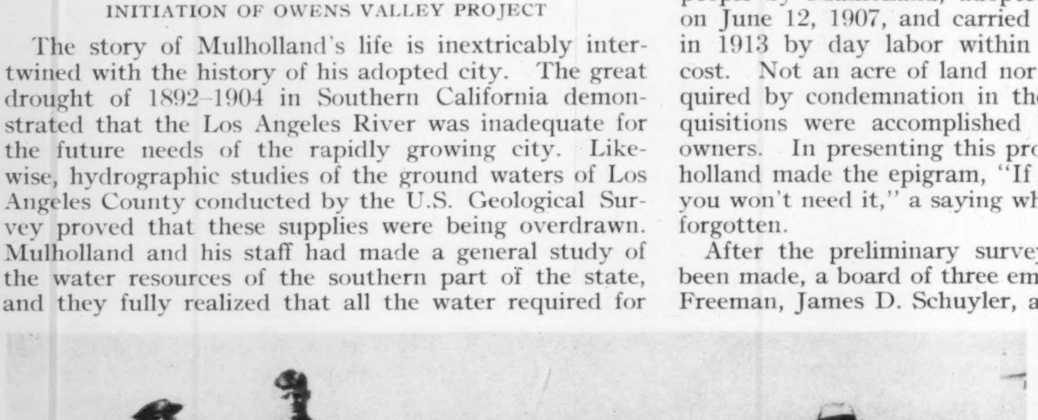
The story of Mulholland's life is inextricably intertwined with the history of his adopted city. The great drought of 1892–1904 in Southern California demonstrated that the Los Angeles River was inadequate for the future needs of the rapidly growing city. Likewise, hydrographic studies of the ground waters of Los Angeles County conducted by the U.S. Geological Survey proved that these supplies were being overdrawn. Mulholland and his staff had made a general study of the water resources of the southern part of the state, and they fully realized that all the water required for Los Angeles for the next ten to twenty years could be cheaply obtained by invading the San Gabriel Valley or the coastal plain. However this would lead to more rapid exhaustion of the vital waters of areas commercially and politically tributary to the town of Los Angeles. It was therefore decided that the municipality should go to a remote region where the minimum injury would be caused by the acquisition and removal of the water, and that it should build as large an aqueduct as could be paid for.

To initiate the project quietly the Water Commissioners of the city assumed the responsibility of paying $150,000 to take up an option on the water rights and a large cattle ranch in Owens Valley, which is situated on the eastern slope of the Sierra Nevada. Following this a bond issue for $2,000,000 was asked for by the city. This transaction was approved by a vote of 7 to 1 on September 7, 1905. This decision was one of the most important events in the history of Los Angeles. It made possible the present population in town and county of 2,785,000.

The plan of building an aqueduct 250 miles long, costing $25,500,000, was proposed to a city of 325,000 people by Mulholland, adopted by a vote of 10 to 1, on June 12, 1907, and carried to successful completion in 1913 by day labor within the estimated time and cost. Not an acre of land nor a drop of water was acquired by condemnation in the Owens Valley; all acquisitions were accomplished by bargaining with the owners. In presenting this project to the people, Mulholland made the epigram, "If you don't get the water, you won't need it," a saying which has never since been forgotten.

After the preliminary surveys to Owens River had been made, a board of three eminent engineers (John R. Freeman, James D. Schuyler, and Frederick P. Stearns, Members Am. Soc. C.E.) was appointed to pass on the project, and they spent about a month preparing their report.

During the construction of the aqueduct many interesting incidents occurred. A. C. Hansen, M. Am. Soc. C.E., who was engineer of the Jawbone Division, was an excellent and successful executive but totally without humor. On one occasion Mulholland was inspecting the construction work on his division, which consisted largely of tunneling. Hansen had been earnestly answering Mulholland's inquiries when the latter suddenly inquired how the "Pinto" tunnel was going.



GROUP OF LOS ANGELES AQUEDUCT ENGINEERS AND CONSTRUCTION SUPERINTENDENTS AT NORTH PORTAL OF ELIZABETH TUNNEL

Mulholland Is in the Front Row, Third from the Left, and J. B. Lippincott Is in the Center, Same Row. Between Them, Standing, Is D. L. Reaburn, M. Am. Soc. C.E. Next to Mr. Lippincott Is Amos A. Fries, M. Am. Soc. C.E., a Major General During the World War

"Fine," Hansen declared, and added with some hesitation, "we have a man caught in there."

"Is he dead?" asked Mulholland.

"No. He is beyond a place that is caved in and we have been talking to him through a 2-in. pipe driven through the muck."

"How long has he been in there?"

"Three days."

"Then," said Mulholland, "he must be nearly starved to death."

"No," replied Hansen, "we have been rolling hard boiled eggs to him through the pipe."

"Well," Mulholland queried, "Have you been charging him board?"

"No," said Hansen, "do you think I ought to?"

The next day the man was extricated.

The aqueduct was completed for a total length, to the San Fernando Reservoir, of 225 miles and a designed capacity of 400 cu ft per sec, sufficient for a population of 2,000,000 people. (As a yardstick for comparison, consider that the aggregate capacity of all the aqueducts of ancient Rome was 210 cu ft per sec.) The Owens Valley Aqueduct, after 28 years of service, has a capacity of over 450 cu ft per sec.

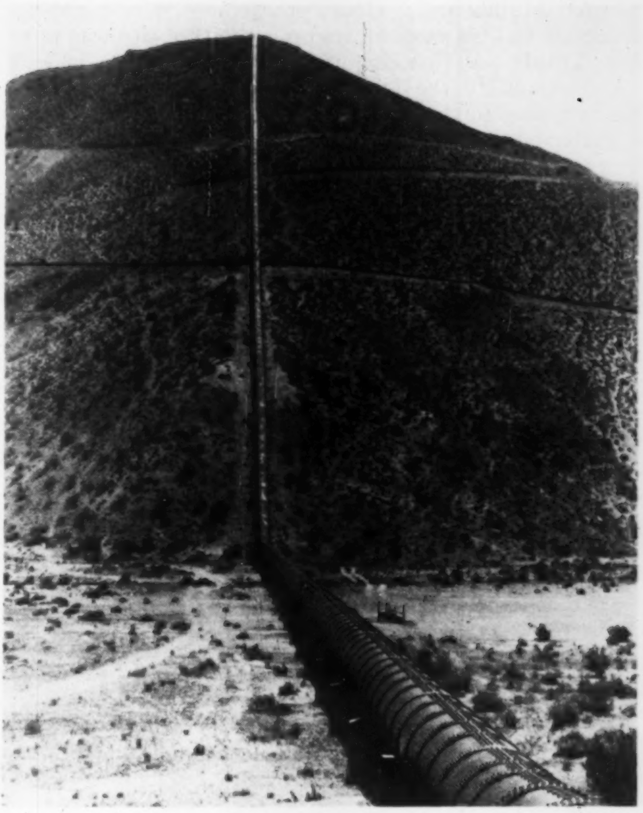
When it was nearing completion the Edison Company offered to buy all the power that could be generated along the line at a rate that would give the city the new water supply practically free of debt. This offer was not accepted by the city.

The following is one of many incidents that portrayed the imagination of Mulholland. Benjamin Holt had recently invented, and brought to the attention of the aqueduct engineers, a type of traction engine which had a broad continuous track running over sprocket wheels in such manner as to give a wide bearing surface and great tractive power. The engineers decided to try it out. Mulholland, among others, was present at the demonstration (about 1909). After watching it operate, he made the remark, in the presence of Mr. Holt, "That thing looks to me like a caterpillar crawling along the ground." Mr. Holt replied "From now on it will be called a 'caterpillar.'" It has retained the name ever since.

Frank Wiggins came to Southern California as an invalid consumptive. He recovered his health there and was for many years the very effective and distinguished manager of the Los Angeles Chamber of Commerce. He played an important role in the great growth of the city in the early years of the century. Mulholland once stated in a speech with characteristic picturesqueness, that the only way to stop the growth of the city would be to kill Frank Wiggins. This shows Mulholland's readiness to appreciate other people's gifts.

MULHOLLAND'S THEORY OF WATER DISTRIBUTION

With the arrival of the aqueduct water the then board of water commissioners outlined a policy of building a pipe distribution system extending beyond the city limits over a much greater area than could be adequately served in order to create competition among buyers of the water. A form of contract was drawn up to be used in the sale of water outside the city boundaries providing that the city could cease delivery whenever the needs of the municipality required. A bond election was called to raise funds to build the conduits. Mulholland and certain of his engineering staff opposed the plan, publicly stating that to use water to develop an area with homes and then withdraw it was cruel and would produce but a temporary and false prosperity. He held that water once put on land should never be removed, that the area of the city should never be greater than could be adequately served with water; and that water should not be sold outside the city limits. The bond issue was defeated and Mulholland's theory of distribution is now embodied in the city charter.



"Jawbone" Siphon on Los Angeles Aqueduct

This was the second decision dealing with water supply for which Mulholland was responsible that profoundly and beneficially affected the future growth of the city. The first was the decision to bring in the new supply from a distant source, rather than to invade developed contiguous areas.

Mulholland's ability consisted in directing efficiently those persons and affairs that he could personally contact and see rather than in broadly supervising an extensive job by studying reports and costs. He once told John Grey, the superintendent of the Elizabeth Tunnel, that he would rather get a shovelful of muck out of the tunnel than all the cost data on the job. This somewhat old-fashioned attitude was no doubt developed by the practical exigencies of the type of work he had been called upon to do. And Mulholland was above all a practical man, a man of action, who liked to get things done rather than merely to talk about doing them. He seldom studied cost and progress reports. During the latter part of his life he was inclined to assume grave responsibilities alone.

The great tragedy of Mulholland's life was the failure of the St. Francis Dam, in 1928. Large storage at the lower or southern end of the Los Angeles Aqueduct is necessary for its safe and efficient operation. (Since the completion of the conduit ten terminal reservoirs have been constructed.) Mulholland proposed a large dam and reservoir in the Big Tujunga Canyon to serve the eastern part of the San Fernando Valley and the City of Los Angeles. Condemnation proceedings were necessary to acquire the site and much adverse testimony was introduced to establish extravagant values, which incensed Mulholland. Court proceedings were abruptly terminated at his request, and a substitute site was purchased in the San Francisquito Canyon.

Unfortunately the foundation rock at practically all the dam sites in the Coast Range of Southern California is shattered and soft, making the construction of dams in these mountains unusually hazardous. The San Francisquito Canyon is no exception. The dam site there was adopted without adequate exploration of the foundations, or consultation.

With the reservoir full of water the dam failed, causing a major disaster. At the Grand Jury investigation that followed, Mulholland's conduct was heroic. When asked who was responsible he answered, "I alone am the man." This reply brought to him the sympathy and respect of the people. He told his friends he wished that he could have been among those who perished.

A TRANSPORTATION PROBLEM ON LOS ANGELES AQUEDUCT CONSTRUCTION ABOUT 1910

Hauling a Section of Jawbone Pipe, Probably $^3/_4$ In. Thick, from Railroad to Siphon Site

One of his few discussions of the disaster took place one day when he was riding with an old friend. The statement was made that Mulholland had immediately removed the doubt of anyone else being to blame by taking the onus on himself. "Yes," he said, "I have never been able to thank the good Lord for my big feet and big nose, but I do thank God that he did give me guts."

In addition to "guts" Mulholland possessed that rare and most valuable ability of leadership. His whole organization loved him from the pick-and-shovel man to the city officials. He kept few notes, had no card index of people or things, but his memory was indelible. When he read a book, its contents were his for life. He was a keen observer. When he rode in an automobile through a new country he would see more than any other passenger in the car. This attribute was of great value to him in forecasting the direction of future city growth and in laying water mains to fit it. His planning was weirdly accurate.

A MAN OF VISION AND A MAN OF ACTION

Mulholland possessed not only vision but also the courage to follow up vision with action, as illustrated by his part in both the Owens Valley Aqueduct and the Colorado River project. He knew that the available water supply of Southern California was the measure and limit of its growth. The Owens Valley supply was inadequate to meet the future demand of the metropolitan area and the Colorado River was the last chance Southern California had for more water.

When a vast reservoir in Boulder Canyon was proposed by the U.S. Bureau of Reclamation, Mulholland visualized an aqueduct from the Colorado River to the coast of Southern California and acted upon the idea. He filed a claim on 1,500 cu ft per sec of the water for the city, June 29, 1924, and put engineering parties in the field to make a general topographic map of the area between the river and the coast.

During the period of initial investigation of the Colorado River project, Mulholland took a party of northern California engineers over the area. They visited Boulder Canyon and stopped over night at Las Vegas, Nev. At breakfast at the railroad restaurant, all the younger men were being polite to the pretty waitress, especially a young red-headed engineer named Cleary, who is now city manager of San Francisco. When the waitress asked Mulholland for his order he said he wanted "some square hot cakes" and insisted that they be "square." When the girl took the order to the kitchen she was so abused by the cook that Cleary went to the rescue, only to be driven out by a display of cutlery. Mulholland did not get his "square hot cakes" that morning, but the next morning at Needles the northern engineers arranged a deal with the chef, and Mulholland was served with hot cakes a foot square.

Mulholland's ability as a hydraulic engineer was recognized throughout the Pacific coast region. He was consulted professionally by the State of California and by many cities and large water companies. He was given the degree of doctor of laws by the University of California in 1915. He was highly educated and had a fine command of English, as may be seen from his annual reports. He became a member of the Society in 1907.

He was frugal in the expenditure of public funds and once said to the writer, "The dollar that I spend I consider to be the greasy, dirty dollar of the working man."

In addition to his fine ability as a civil and mechanical engineer, as demonstrated by the water system of Los Angeles as it exists today, he had a love of music, literature, and flowers. On one of the rare occasions when he was in a depressed mood, the writer induced him to take a trip to the San Fernando Valley with him and Mrs. Lippincott. After considerable urging Mulholland consented to go. He sat on the back seat with Mrs. Lippincott, who was one of the few people who could compete successfully with him in repartee. In her girlhood she had sung a part in the Mikado and remembered its lines. As they drove along she began to sing snatches from it. To her surprise Mulholland joined in the responses and the two sang a good portion of the opera on the trip through the valley. Mulholland's depression vanished with the song. He not only knew the Gilbert and Sullivan operas but also was personally acquainted with Sullivan, the composer, who at one time had lived in Los Angeles.

Mulholland purposely covered a deep and sensitive heart with a gruff exterior and only in rare moments would speak of his inner emotional experiences. He was a great and good man.

More than any other man, he made the City of Los Angeles what it is today, not to mention his contribution to the future expansion of all Southern California. When Mahomet was asked what was the greatest act of charity, the son of the desert replied, "To bring water to men." Mulholland delivered the waters of three rivers to the city of Los Angeles. The true success of a man's life may be gaged by the benefit he has rendered the community in which he has lived. By that standard Mulholland should be judged as one of our very best citizens.

Runways for the Washington National Airport

By E. L. TARWATER

HIGHWAY ENGINEER, U.S. PUBLIC ROADS ADMINISTRATION, WASHINGTON, D.C.

PAVING an air field takes on the aspect of a major highway project when, as in the case of the Washington Airport, the job is equivalent to a modern dual highway from the Capitol to Baltimore. Fortunately plenty of hydraulic fill was available from the Potomac to extend the field out into the river. When the sub-base had been laid, it was stabilized with nearby binder soil. A prime application of tar was followed by a hot asphaltic mix in two courses, using dredged aggregate. A description of experiments with rubber-tired rollers for base compaction is an interesting feature of this paper, originally given before the Highway Division at the Society's Annual Meeting in January.

MOST conveniently located on the west side of the Potomac River (Fig. 1), the Washington National Airport comprises about 730 acres, of which 350 were originally mud flats below high tide in the Potomac River. The remaining acreage is adjacent land in Arlington County, Va. The four runways have a combined length of 21,195 ft. They are connected, one with another and also with the central terminal building, by some 11,000 ft of paved taxiways. Adequate gravel shoulders were constructed along both the runways and the taxiways.

As an illustration of the magnitude of this project, the paving of the runways, taxiways, and aprons comprised a total of 677,000 sq yd, the yardage required for the construction of approximately 60 miles of a 20-ft paved road. The project also involved the relocation and paving of $1^3/_4$ miles of the Mt. Vernon Memorial Highway, in two 24-ft lanes, and the construction of 6 miles of access roads, as well as parking facilities for approximately 5,000 automobiles.

Responsibility for pumping about $19^1/_2$ million cu yd of hydraulic fill, as well as for other major phases of the construction, was assigned to the Washington District office of the U.S. Engineers. Numerous test borings made in advance to determine the character and adaptability of the underlying material disclosed that the top layer, some 10 to 12 ft in depth, was composed chiefly of compressible silt, with insufficient bearing power to carry the runways. This unsuitable material was therefore removed by trenching with dredges and was pumped outside the area of the runways. Then the dredges were placed out in the river, from which selected gravelly material could be obtained for replacement in the trenches. During this filling operation the discharge line from the dredges was placed on the approximate center line of the runway so that any remaining muck would be forced outward, leaving the best material distributed along the length of the runway proper.

Because of the great area and correspondingly high cost of airport runways, serious consideration must be given to the problem of paving in order to produce a suitable and durable landing surface at a cost that is not prohibitive; the problem is one of utilizing locally available materials to the best possible advantage. Since the Potomac River would furnish excellent sand and gravel in almost unlimited quantities, this problem was considerably simplified.

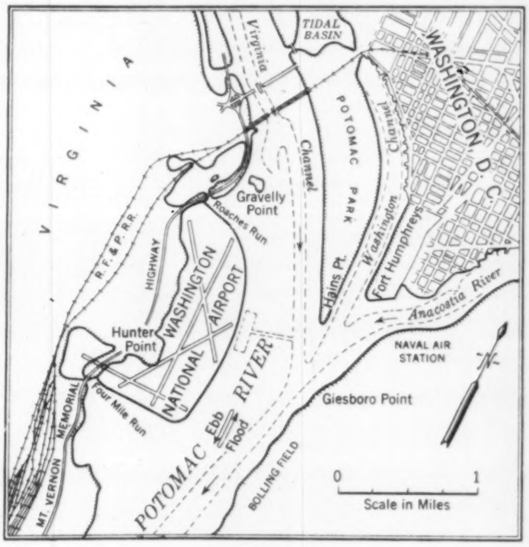


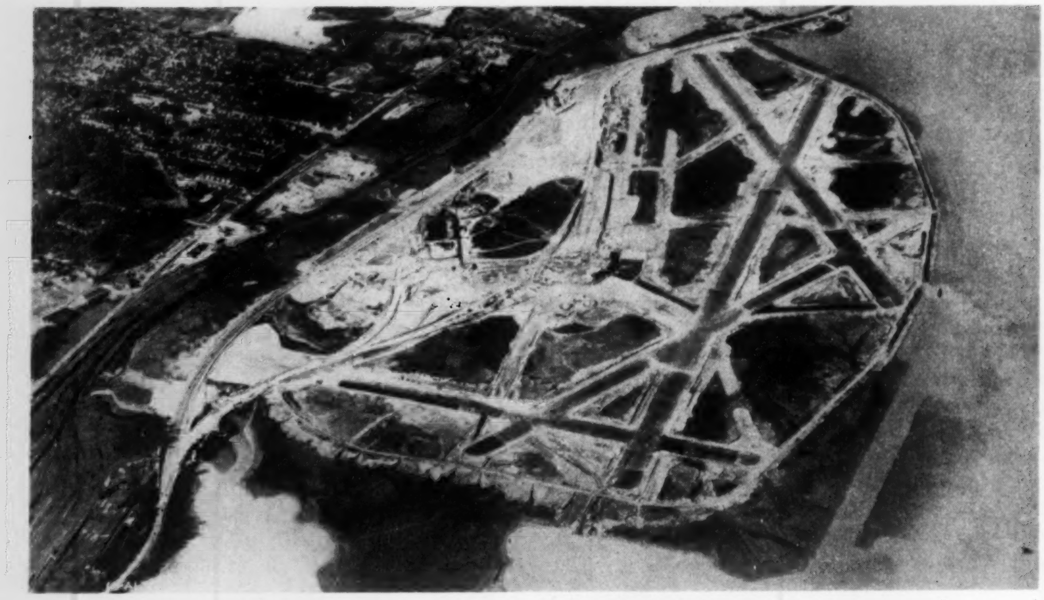
FIG. 1. LOCATION MAP OF AIRPORT IN RELATION TO THE CITY OF WASHINGTON

An investigation by the Public Roads Administration revealed that the sand and gravel pumped in during the runway construction was non-uniform in character, was unstable, and showed a marked deficiency in the binding material and fines required to produce a satisfactory base course. Surrounding upland areas, however, contained an adequate quantity of binder soil which could be added to produce an excellent base course of sufficient stability. Accordingly specifications were prepared for this purpose. The work to be done consisted of scarifying the existing surface of the runways, removing oversize stones, adding binder soil in the necessary quantities, and disking and rolling to produce a well-compacted stabilized sub-base 9 in. thick.

This work was done by force account, the U.S. Engineer Department acting in the capacity of contractor and furnishing all engineering work. The Public Roads Administration conducted all laboratory tests and was responsible for inspection.

In the first operation the existing runways were scarified with a tractor-drawn heavy-duty rooter to loosen the surface and expose oversize boulders. All material greater than 3 in. in diameter was removed by WPA hand labor. The surface material was further blended by tractor-drawn cultivators and the hand scalping continued. Meanwhile samples were collected from the loosened surface and tested in a portable field laboratory. The needed binder soil was then loaded by hand, transported by truck, and spread by hand in the required amounts. It was blended in by tractor-drawn disks and cultivators. By repeated check tests the proper amounts of binder soil and of mixing were determined to produce uniform material.

In the early stages, difficulty was encountered in mixing the material to the proper depth. This was overcome by loading the disk harrows and by using supplementary gang plows to turn the added binder soil under. Then the entire area was bladed to a uniform cross section and checked for grade. Sufficient allowance was made to allow for compaction. During stabilization, numerous soft spots or mud pockets were encountered, which were removed immediately to a depth of about 3 ft and backfilled with select material. After compaction of the surface with rubber-tired rollers, density tests were made to determine when



AIR VIEW LOOKING NORTH ALONG MAJOR RUNWAY (6,875 FT)
Other Runways Are 5,300, 4,820, and 4,200 Ft (East-West)

the proper results had been obtained. There was little difficulty in securing a density of 130 to 140 lb per cu ft.

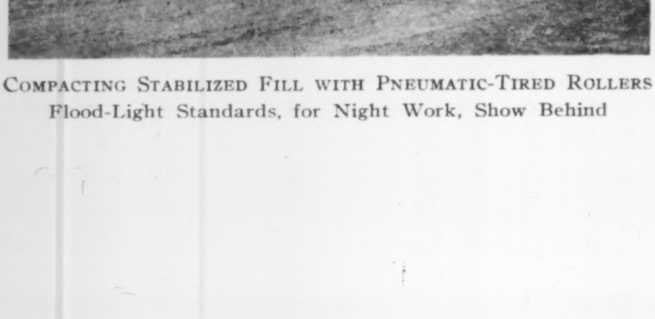
During the construction of this stabilized base course it was felt that a sheepsfoot roller might give better compaction. To settle this question, two adjacent areas of equal length on a runway were set aside, one for compaction with each type of roller, and density tests were made after an equal number of trips with each. The two areas were then compacted to the required density, counting the number of trips required and the costs. It was found that satisfactory compaction could be obtained with the rubber-tired roller in less time, with fewer trips, and at less cost than with the sheepsfoot roller. Because of the boulders and gravel particles present, the sheepsfoot roller tended to slide sideways, disturbing the area already compacted. Thereafter the rubber-tired roller was used entirely for initial compaction.

During the compacting and smoothing operations, sprinkler wagons continually applied water to the surface. When the approximate proper density had been acquired, the surface was rolled with a 3-wheeled 10-ton roller and again checked for grade. Any deviations of ±1/2 in. from true grade were corrected by hand patching. The runway was then rolled with a tandem roller to produce a uniformly smooth surface.

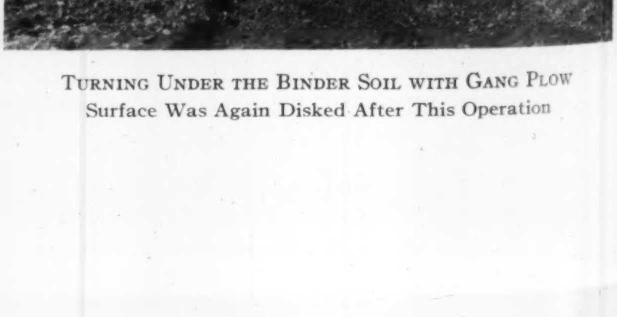
To this finished surface a prime application of tar, having a specific viscosity of 8 to 13 at 40 C, was made by a pressure distributor at the rate of approximately 0.3 gal per sq yd.

On the areas first stabilized, numerous soft spots not detected during construction developed under the wheels of the distributor. To dig out and backfill these caused further work on areas that had been thought completed, and required a considerable amount of spot priming. Since the weight exerted on the surface by the distributor wheels was less than could be expected from a heavy plane in landing, the seriousness of this condition was apparent. A loaded solid-tired truck, having a gross weight of approximately 12 tons, continually patrolling the runways, proved most effective in locating pockets that had been trapped in the hydraulic fill during construction. After this procedure was instituted, no further trouble was encountered during or after priming operations. To keep the stabilization work ahead of the paving, it was necessary to work two shifts daily for a total of 80 hours a week, with artificial lighting for night work. In all, 28 lighting units with 4 flood lights each were used.

Another investigation conducted by the Public Roads Administration was to determine whether the available materials were suitable for constructing an asphalt wearing surface. The natural product proved adequate for the binder course, but approximately 15% of crushed aggregate and 5% of mineral filler had to be added to the material passing the 3/4-in. sieve, to give a mixture of suitable stability and predicted durability for a wearing surface. Numerous gradations and combinations of aggregates were studied, and various experiments made with both hot and cold asphaltic materials of widely different consistencies. It was decided that a hot bituminous-concrete plant mix, using an asphalt cement of 120 to 150 penetration, would give the most suitable surface. These conclusions were drawn from a study of the stability of mixtures in which the different asphalt cements had been used. It was thought that this high-penetration asphalt, in addition to its natural stability,



COMPACTING STABILIZED FILL WITH PNEUMATIC-TIRED ROLLERS
Flood-Light Standards, for Night Work, Show Behind



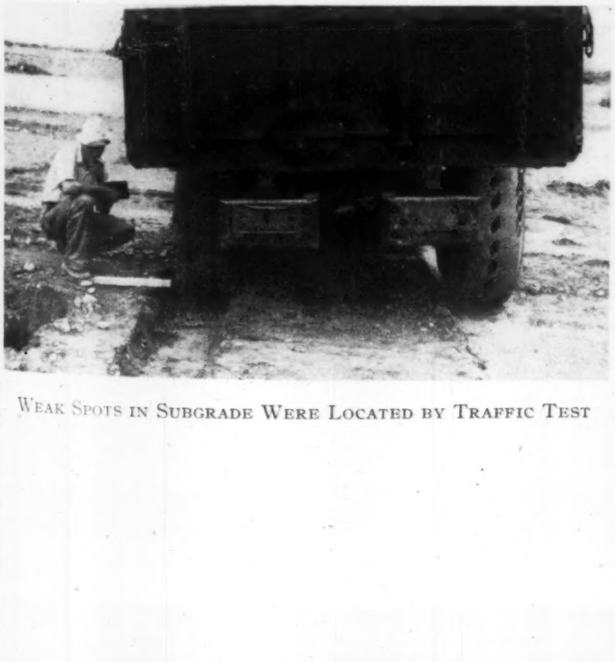
TURNING UNDER THE BINDER SOIL WITH GANG PLOW
Surface Was Again Disked After This Operation

would minimize damage through cracking or disintegration resulting from continuous exposure to the hot sun. It was also found that the mix proposed would furnish a satisfactory surface texture, as the coarser particles are well embedded in the fines and there is little likelihood of raveling under traffic; yet the whole can be sealed tightly enough to render it reasonably impervious.

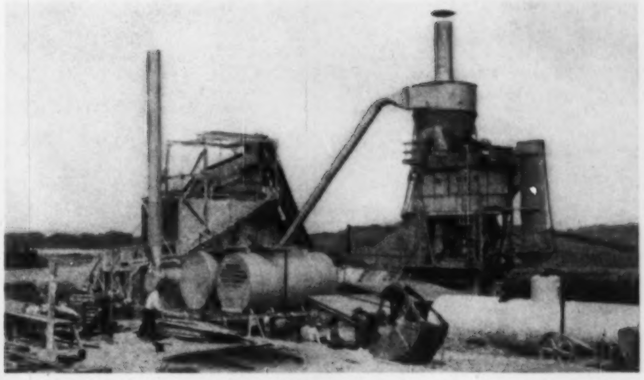
Typical Mud Pocket Disclosed During Stabilization of Base

In accordance with the results of these investigations, the U.S. Engineer Department pumped in during the dredging operations a stockpile of materials of sufficient quantity to furnish the aggregate for the bituminous surfacing of the runways, taxiways, aprons, and access roads. Specifications called for the erection nearby of a modern asphalt plant capable of producing a minimum of 75 tons of hot asphaltic concrete mixture per hour, to be placed by self-propelled asphalt spreaders on the runways. A 2-in. binder course and a wearing course $1^{1}/_{2}$ in. in thickness were required.

For the gradings, as given in Table I, the proportion of bitumen to total aggregate, by weight, was 5 to 7% for the base course and 5 to 9% for the wearing course. The asphalt cement had the following qualities: (1) specific gravity 25 C/25 C, 1.00+; (2) flash point, 175 C+; (3) softening point, 35 to 55 C; (4) penetration at 25 C (100 grams, 5 seconds), 120 to 150; (5) ductility at 25 C, 100+; (6) loss at 163 C (5 hours), 1.0%−; (7) penetration of residue, as compared to penetration before heating, 60%+; (8) bitumen (soluble in carbon disulfide), 99.5%+; (9) organic matter, insoluble, 0.2%−; (10) inorganic matter, insoluble, none; (11) oliensis spot test, negative. At the turn-arounds beyond the runways, where shearing and twisting are expected, similar asphalt was used except that the softening point was 40 to 60 C and the penetration 85 to 100.



Weak Spots in Subgrade Were Located by Traffic Test



Asphalt Plant—Screening at Left, Mixing at Right

Although the contract for the asphalt concreting was awarded to the Warren Brothers Roads Company of Cambridge, Mass., on April 12, 1940, no material was laid until June 10, 1940. In the first period of construction, 80,000 tons of material were to be placed in 130 calendar days; actually it was accomplished in 129 days. During a second period, in which material was to be placed at a rate not exceeding 75 tons per hour, 32,500 tons were placed, including 6,303 tons for paving the relocated Mt. Vernon Memorial Highway.

The plant set-up consisted of a screening unit to which the aggregates from the stockpile were delivered by a 12-cu yd earth mover and fed by a bulldozer into the storage bin through a 5-in. grizzly, in order to remove oversize material. Thence the aggregate was carried by bucket elevator to a double-deck vibratory screen above five storage bins of 120-cu yd total capacity, for material (1) larger than $2^{1}/_{2}$ in., (2) $2^{1}/_{2}$ to $1^{1}/_{4}$ in., (3) $1^{1}/_{4}$ to $^{3}/_{4}$ in., (4) $^{3}/_{4}$ to $^{5}/_{16}$ in., and (5) $^{5}/_{16}$ in. to dust. Provision was made for drawing material from any bin into trucks, to overcome non-uniform grading, as well as for feeding direct to the cold elevator by means of electric vibratory feeders. The rate of feed from each bin through these feeders was controlled by rheostats which regulated the pulsation of the feeders. During the mixing of the wearing course, the material from the $2^{1}/_{2}$ to $1^{1}/_{4}$-in. bin was crushed to produce the 15% of crushed material required under the specifications.

Table I. Gradations of Materials for Asphaltic Concrete, in Per Cent

Size Screen (Square Mesh)	Approx. Stock Pile (Material Over $1^{1}/_{4}$ In. Removed)	Limits of Base Course	Approx. Stock Pile (Material Over $^{3}/_{4}$ In. Removed)	Limits of Wearing Course*
Passing:				
$1^{1}/_{4}$ in.	100	100	...	...
$^{3}/_{4}$ in.	85	60–95	100	100
$^{3}/_{8}$ in.	70	40–75	80	60–85
No. 4	55	35–60	65	50–65
No. 10	40	30–45	45	35–50
No. 40	17	10–25	20	15–30
No. 100	5.0	0–15	7.0	5–15
No. 200	0.5	0–5	0.7	5–8

* After introducing approximately 15% of crushed material and 5% of mineral filler.

In the early period of construction, numerous crusher jaws were broken by cannon balls and other forms of scrap iron pumped in from the river by the dredges. This trouble was overcome by using a magnetized conveyor belt which removed all iron particles before they reached the crusher. The heated aggregate from the drum was separated by vibratory screens into four sizes: $1^{1}/_{4}$ to $^{3}/_{4}$ in., $^{3}/_{4}$ to $^{3}/_{8}$ in., $^{3}/_{8}$ in. to No. 8 mesh, and No. 8 mesh to dust. The capacity of the storage bins that were at the top of the mixing plant was approxi-

HOT ASPHALTIC CONCRETE DUMPED FROM TRUCK INTO SPREADER

mately 50 tons. Thence the aggregates, including mineral filler, were drawn into the weighing hopper. The mixing box was a steam-jacketed twin pug-mill of 5,000-lb capacity equipped with runaround paddles or mixer blades. Following a dry mixing period of 15 seconds, the asphalt cement was introduced and mixing continued for an additional 45 seconds. Charts from a recording pyrometer giving temperature variation for the asphalt at the discharge end of its line, for the aggregate as it left the heating drum, and for the aggregate in the weigh box, provided for excellent temperature control.

After delivery by truck to the runways, the hot asphaltic concrete was spread on the previously prepared base course by two self-propelled spreaders. All longitudinal joints between the two courses of the wearing surface were staggered to avoid planes of weakness. Steel forms set to grade along the edges of the runways controlled the depth of the loosely spread mixture. For intermediate lanes, steel pins were set to grade; over them a piano wire was tightly stretched and held in place to support a small metal rider, which was attached to the free end of the screed. An indicator controlled by this attachment registered on a graduated scale; by adjusting the height of the screed the required depth of material could be spread. Allowances had to be made for the differences in compaction expected from different depths of materials. On subsequent lanes the outside end of the screed was allowed to ride the surface of the lane previously spread. This method proved quite effective in controlling the elevation of the loosely spread material; however, because of the very flat longitudinal grade and the transverse grade of only 1%, some patch work was required to eliminate variations of more than $^1/_4$ in. from true grade, as called for under the specifications.

Variations in the aggregate stockpile made it necessary to change the plant mix formula from time to time. Since the contract required payment for all processed material produced and not used, other changes were required in the interest of economy. For these reasons daily samples of the mixture were collected and tested for compliance with the plant-mix formula. At frequent intervals samples of both the binder and wearing courses were cut from the completed pavement and tested not only for composition and density but also for recovered bitumen to determine the effect of the processing on its consistency. Little change in penetration was found; all samples came well within the specification requirements of at least 50% of the original penetration and a ductility of not less than 100 cm. Compaction was obtained by five gasoline-powered rollers, of which four were 7-ton tandems and one was a 3-axle roller weighing about 13 tons, for final rolling or smoothing.

At the beginning the plant operated 14 hours a day. But delay in starting the actual paving operations had caused the project to run behind the planned schedule; therefore a third 7-hour shift was added on June 27, 1940. As specifications required the wearing course to be laid during daylight hours, only binder course was placed at night. Progress on the night shift was not equal to that on the other two shifts nor was the workmanship as good. By early fall, however, paving operations had substantially caught up with construction of the base, and the night shift was discontinued on September 28.

By this time practically all paving on the runways proper had been completed, leaving only some of the taxiways, aprons, and access roads to be done under the second period of the contract. This period began on September 28, and paving continued until December 21, 1940, when the contract time expired. As of March 1, 1941, the paving remaining to be done consisted of a portion of two taxiways and aprons and the majority of the 6 miles of access roads throughout the area. It is planned to continue the work, consisting of the placing of about 35,000 tons of bituminous mixture, in the early spring in order that the project may be fully completed in the early fall of 1941. During the winter, work was continued on drainage, landscaping, grading, construction of gravel base, and other features of the access roads and parking areas which form a part of the project.

Construction of the Washington National Airport is under the Administrator of Civil Aeronautics, through the Interdepartmental Engineering Commission. The valuable assistance of the U.S. Engineer Corps and of the Public Roads Administration has been mentioned.

GENERAL VIEW OF PAVING OPERATIONS

On the Four Regimes of Open-Channel Flow

Experiments Emphasize Distinction Between Laminar-Turbulent and Tranquil-Rapid Classifications

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STATEMENTS to the effect that there are only three stages of open-channel flow may be traced through more than a decade of hydraulic literature. Not only are these stages classed as laminar, turbulent, and shooting, but the Reynolds number and the Froude number are used, respectively, to define the lower limit and the upper limit of the intermediate stage. Needless to say, the literature of the same period contains sufficient analytical material to indicate the fallacy in these statements, but experimental evidence to support this material does not seem to be available. It is the purpose of the writers to present such evidence; while the experimental attainment of flow which is at once both laminar and shooting should be sufficient in itself, further tests are described to emphasize the distinction between two basically different stage criteria.

As was shown many years ago by Osborne Reynolds, the dimensionless number $VD/\nu = 2{,}000$ marks the approximate dividing line between laminar and turbulent flow in pipes, V representing the mean velocity, D the diameter, and ν the kinematic viscosity. This criterion is purely a viscous one, obviously having nothing to do with the acceleration of gravity. For open channels, on the other hand, a different type of critical number is that dividing tranquil flow from rapid or shooting flow. This is the Froude criterion, $V/\sqrt{gy} = 1$ (g being the acceleration of gravity and y the depth of flow), which may also be regarded as the border between velocities lower and higher than that of a very small gravity wave. The latter criterion, obviously, has nothing to do with viscosity.

While the Froude number applies only to flow with a free surface, in which gravitational action may be effective, the Reynolds number is as applicable to free-surface flow as to flow that is entirely confined within conduit walls. One may therefore assume, as a first approximation, that the critical value $VD/\nu = 2{,}000$ is numerically correct for a very wide channel if written in the form, $Vy/\nu = 500$ (that is, through use of the fact that the diameter of a pipe is four times the hydraulic radius, R, and the hydraulic radius of a very wide channel is approximately equal to the depth). It is then a simple matter to plot on a graph of y versus V the line $\mathbf{R} = Vy/\nu = 500$, which should mark the border between the zones of laminar and turbulent flow for various values of y and V. Likewise, the line $\mathbf{F} = V/\sqrt{gy} = 1$, which separates the zones of tranquil and rapid flow, may be plotted on the same graph. As may be seen from Fig. 1, the intersection of such lines indicates the existence of four different regimes of flow: (1) tranquil-laminar, (2) rapid-laminar, (3) tranquil-turbulent, and (4) rapid-turbulent.

Regimes 3 and 4 are so well known to the engineer that they warrant little further comment. Regimes 1 and 2, on the contrary, are very seldom observed in open-channel hydraulics, owing to the low rates of flow necessary to their existence. They are, nevertheless, familiar phenomena of everyday life, unlikely as they are to attract professional attention; the flow of rain water down a roof or sidewalk, for instance, is more apt than not to illustrate the tranquil-laminar or the rapid-laminar regime. As a matter of fact, flow of this nature may also be encountered in two fields of engineering—hydraulic model testing and the control of so-called sheet-flow erosion. Recognition of the existence of all four regimes is therefore of more than academic importance, for an understanding of the differences in their hydraulic action can have considerable practical value.

The slope S necessary to yield uniform laminar flow at a given velocity and depth in a very wide channel may be computed from the following relationship, comparable to the Poiseuille equation for laminar flow in pipes and involving the velocity and depth, the dynamic viscosity μ, and the specific weight γ:

$$S = \frac{3\mu V}{\gamma y^2}$$

Similarly, the slope for uniform turbulent flow in smooth channels of very great width may be obtained from the following relationship, comparable to the Blasius equation for smooth pipes:

$$S = \frac{0.059}{(Vy/\nu)^{1/4}}\,\frac{V^2}{2gy}$$

These expressions differ numerically from those for pipes, owing to the difference in the integral of similar velocity-distribution curves over dissimilar shapes of flow section. The variation of y with V in accordance with

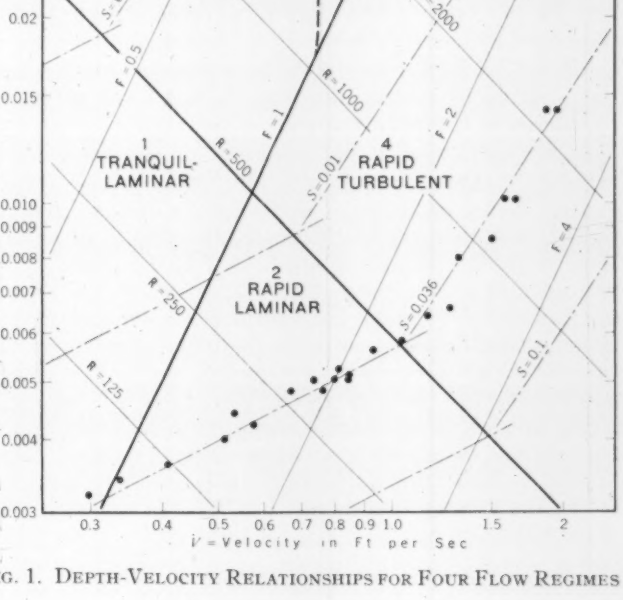


Fig. 1. Depth-Velocity Relationships for Four Flow Regimes

these relationships is shown in Fig. 1 for several different slopes. In each case the intersection of the lines for the laminar and turbulent regimes occurs approximately at $Vy/\nu = 500$. Similar plots of the Poiseuille and Blasius equations in terms of the hydraulic radius would intersect at about $VR/\nu = 300$, which is lower than the critical value of 500 used in practice; this would indicate that the corresponding critical Reynolds number for very wide channels is higher than that for pipes, simple proportion yielding a value of around 800.

Experimental tests to illustrate these conditions were made in a small channel 6 in. wide and about 4 ft long, set at an arbitrary slope of $S = 0.036$. Depth measurements were made with a vernier point gage, and discharge measurements with a calibrated volumetric tank. Aside from the computed magnitudes of the Froude and Reynolds numbers as criteria for the flow regimes, the existence of laminar or turbulent flow was checked by the use of dye, and the existence of tranquil or rapid flow by the absence or presence of the hydraulic jump at the upstream limit of backwater from a tail gate. That the measurements of depth and velocity were in satisfactory agreement with the analytical plots of Fig. 1 may be seen from the proximity of the experimental points to the computed lines for the given slope. And that the flow in each of the three zones investigated was as expected is evident from the photographs in Fig. 2.

In each photograph the flow is from left to right, backwater producing an abrupt change from uniform to non-uniform motion at the same location just right of center. The top view represents flow at a Froude number slightly below the critical. The slope, $S = 0.036$, is approximately the so-called critical slope for the existing discharge, and the free surface therefore becomes horizontal in the non-uniform region. That the transition takes place without the hydraulic jump is due to the fact that the velocity is below that of a wave; and that the dye stream is not diffused is evidence of laminar flow in both regions. The middle view shows the case of rapid-laminar flow, and therefore embodies the principal evidence of this paper. The fact that the uniform flow is laminar is seen in the streak of undiffused dye; and the fact that it is rapid is indicated by the formation of the jump. This condition is generally typical of the measured points midway between the Froude and Reynolds critical lines in Fig. 1. The final view serves merely to show, in contrast to the other two, a case of rapid-turbulent flow corresponding to the measured points near the line **R** = 1,000. The fourth possible case—that of tranquil-turbulent flow—is not illustrated, because it could not be obtained with the slope chosen for investigation; it is, of course, the flow regime most often encountered in rivers and canals.

In connection with the criterion for the existence of rapid flow—the formation of the hydraulic jump—several comments are pertinent. If the depths of flow involved in the jump are relatively small, the effects of surface tension become of such magnitude that the phenomenon can no longer be regarded as a function of the Froude number alone. In fact, both surface tension and gravitational attraction must normally be included in the expression for the elementary wave velocity. It is often stated, as a result, that the combined action of gravity and capillarity is such that the minimum wave velocity at the free surface of the water is about 0.76 ft per sec. As a matter of note, this particular condition of flow applies to depths greater than about 0.017 ft (as shown by the vertical broken line in Fig. 1 for pure water at 65 F), for below this depth the minimum wave velocity happens to be controlled by gravity alone. Evidently all measured points in the rapid-laminar zone represent velocities truly greater than that of a surface wave at the existing depth of flow.

On the other hand, the very fact that waves may exist often tends to conceal the fundamentally laminar nature of Regime 2. That is, the rapid variation in depth caused by the passage of so-called roll waves may produce a local state of turbulence even though the undisturbed flow is well below the critical Reynolds number. (The lower the value of **R**, of course, the greater must be the disturbing effect of the wave to cause the flow to become even momentarily turbulent.) In this connection it should be noted that such intermittent or "slug" flow may be shown to be possible in the laminar regime once the Froude number for uniform flow is greater than 0.5, whereas in uniform turbulent flow in smooth channels the Froude number must be greater than 1.4. Intermittent pulsations of this nature caused no trouble in the present experiments except at the highest rates of flow, in part because all possible sources of disturbance were eliminated, and in part because the channel was no longer than was necessary to insure the existence of uniform flow. Comments by other investigators, who invariably seem to have encountered both pulsations and turbulence with low rates of flow on steep slopes, lead one to suspect that herein lies the reason for their failure to recognize the rapid-laminar regime.

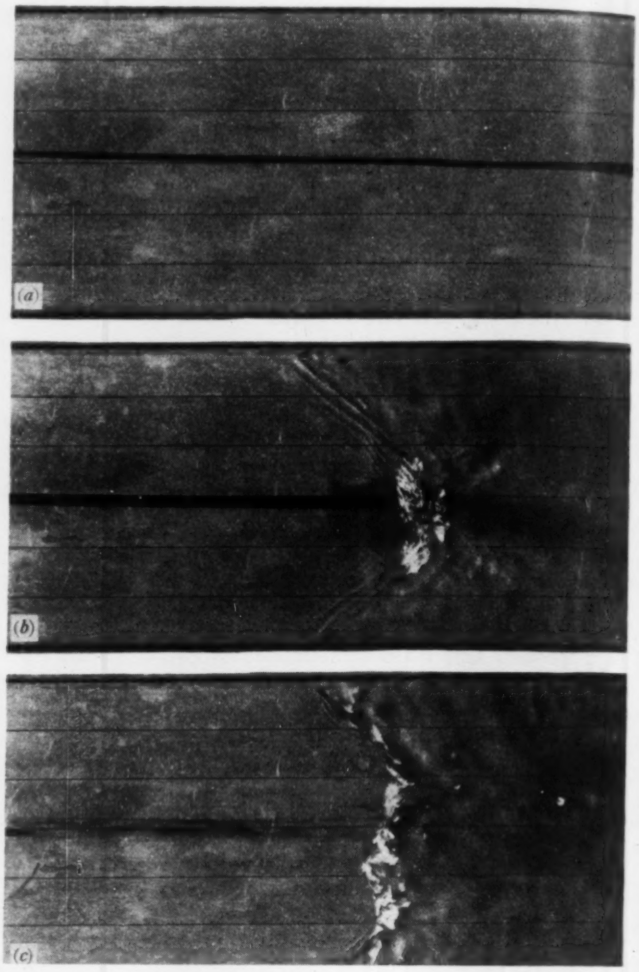


FIG. 2. PHOTOGRAPHS OF FLOW IN LABORATORY CHANNEL: (a) TRANQUIL-LAMINAR, (b) RAPID-LAMINAR, (c) RAPID TURBULENT

Since both the Froude and the Reynolds criteria must be used in designating the four regimes of open-channel flow, certain anomalies in present-day nomenclature will soon become apparent. Although the terms "tranquil" and "rapid" have been used herein in connection with the Froude criterion, they are not altogether satisfactory. "Rapid" is perhaps the more appropriate of the two, for with a slight stretch of the imagination it can be associated with the fact that rapids may form only if the velocity is above the Froude critical. "Tranquil," on the other hand, would seem to indicate the absence of turbulence rather than a lack of speed. Search for a word more nearly the antonym of "rapid" is quite fruitless, however, for it yields only "languid," "torpid," and "slow"—all of which come too near a state of complete stagnation to be desirable. As a matter of fact, the question of slowness or rapidity is no more characteristic of the Froude criterion than of the Reynolds—or, indeed, of the Weber and Cauchy criteria for capillary and elastic effects. The frequently used terms "low-velocity" and "high-velocity" are therefore just as inept as the ambiguous "subcritical" and "supercritical."

Such considerations appear to leave only two general possibilities: the choice of terms associated with the gravity-wave velocity, similar to the words "subsonic" and "supersonic" commonly associated with the Cauchy criterion; or terms that are inherently descriptive, as are "laminar" and "turbulent" in connection with the viscous criterion of Reynolds. Of the first category, "subundial" and "super-undial" immediately suggest their connection with the wave velocity—although, unfortunately, they are fully as descriptive of capillary and elastic waves as of waves of the gravity type. Of the second category, the terms "streaming" and "shooting" were once adopted in this country as literal translations from the German; they are now however by no means standardized, perhaps because of their varied connotations. On the other hand, the word "torrential" has long since been in common use for that class of flow normally characteristic of mountain streams; as an antonym what could be more descriptive than the word "fluvial" to describe flow at a Froude number less than unity? Since the ultimate choice of nomenclature must depend upon popular opinion among hydraulic engineers of this country, it is hoped that further thought on the subject may be stimulated by these comments.

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

The Decimal Point in Slide-Rule Computations

By W. D. McFarlane, Assoc. M. Am. Soc. C.E.
Field Engineer, City Engineer's Office, Detroit, Mich.

In slide-rule calculations, a misplaced decimal point may mean a failure. Therefore the following simple method of determining the proper position may be helpful. Slide-rule handbooks give four rules for determining the decimal point when using the C and D scales, and four more, the reverse of the first four, for the CI and D scales. This makes eight rules to remember if the C and CI scales are to be used efficiently. As a result some engineers use only the C and D scales, or the CI and D scales, and thereby perform additional operations that would be unnecessary if they were able to use both the C and the CI scales.

When the writer took University of Wisconsin extension work that required extensive slide-rule calculations, he accidentally found the following method, which employs but one rule for determining the decimal point whether for the C and D scales or for the CI and D scales.

For this method, the characteristics of the common logarithms are used. When using the C and D scales (black) add +1 to the characteristic of either the numerator or the denominator if the slide extends to the left, depending upon whether the operation is multiplication or division. When using the CI and D scales (red and black) add +1 to the characteristic of either the numerator or the denominator if the slide extends to the right, depending upon whether the operation is multiplication or division.

It is not necessary to write the characteristics as shown in the following example, for they are very easily carried mentally.

Example:

$$\frac{\overset{+6}{(1{,}250{,}000.)}\;\overset{\overset{+\mathit{1}}{-1}}{(0.813)}\;(2)\;\overset{\overset{+\mathit{1}}{+4}}{(15{,}900.)}\;\overset{-2}{(0.0107)}}{\underset{\underset{+\mathit{1}}{+1}}{(64.3)}\;\underset{\underset{+\mathit{1}}{-1}}{(0.426)}\;\underset{\underset{+\mathit{1}}{+1}}{((52.7)}\;\underset{\underset{+\mathit{1}}{-1}}{(0.429)}} = \overset{+9-(+4)=+5}{560{,}000.}$$

Note: Corrections to characteristics are in italic.

Procedure:

CI and D: (1,250,000.) (0.813), right extension, add +*1* to numerator.

CI and D: dividing by (64.3), right extension, add +*1* to denominator.

CI and D: multiplying by (2), left extension, decimal remains the same.

C and D: dividing by (0.426), left extension, add +*1* to denominator.

C and D: multiplying by (15,900), left extension, add +*1* to numerator.

C and D: dividing by (52.7), left extension, add +*1* to denominator.

CI and D: multiplying by (0.0107), left extension, decimal remains same.

C and D: dividing by (0.429), left extension, add +*1* to denominator.

Add numerator and denominator algebraically, which gives +9 in the numerator and +4 in the denominator.

Subtracting the characteristics of the denominator from those of the numerator, +9 − (+4) gives +5, which is the characteristic of the answer.

If the characteristic of the numerator had been +9 and that of the denominator −4, the characteristic of the result would have been +13.

If the characteristic of the numerator had been −9 and that of the denominator −4, the characteristic of the result would have been −5.

If the slide should not have a decided extension to right or left, interchange the factors until there is a decided extension.

Nomograph Shows Economic Pipe Size

By BENJAMIN C. SEAL, ASSOC. M. AM. SOC. C.E.

FIRST LIEUTENANT, CONSTRUCTION DIVISION, QUARTERMASTER CORPS, U.S.A., ORDNANCE PLANT, ST. LOUIS, MO.

FOR finding the economic size of water pipe, the writer has prepared a nomograph (Fig. 1) that takes into consideration all the principal factors for several kinds of pipe. It is based on the Babbitt and Doland formula as enlarged upon by Thomas R. Camp, M. Am. Soc. C.E. ("Economic Pipe Sizes for Water Distribution Systems," TRANSACTIONS, Am. Soc. C.E., Vol. 104, 1929, p. 190). Mr. Camp states that 20 per cent is allowed for contractor's profit, engineering, insurance, and interest during construction. Excavation is assumed to be ordinary soil without pumping, sheeting, or other unpredicted costs. In drawing the nomograph, a Hazen-Williams friction coefficient of 120 has been used, although a correction table is added for other values. Pumping efficiency is assumed to be 75 per cent. Annual rate of interest plus depreciation is taken as 6%. Lead and yarn are taken at 5.8 and 12 cents per lb, respectively.

From a study of recent bids in which lined steel pipe and reinforced-concrete pipe competed with cast-iron pipe on an equal basis, it was possible to add these to the nomograph. Standard steel pipe 12 in. in diameter and smaller was also added. A value for the latter was arrived at by comparing weights of cast-iron and steel pipe with current prices. Labor involved in connecting and installing these two types is assumed to be the same. The cost of lead and jute is believed to offset the cost of providing threads and couplings.

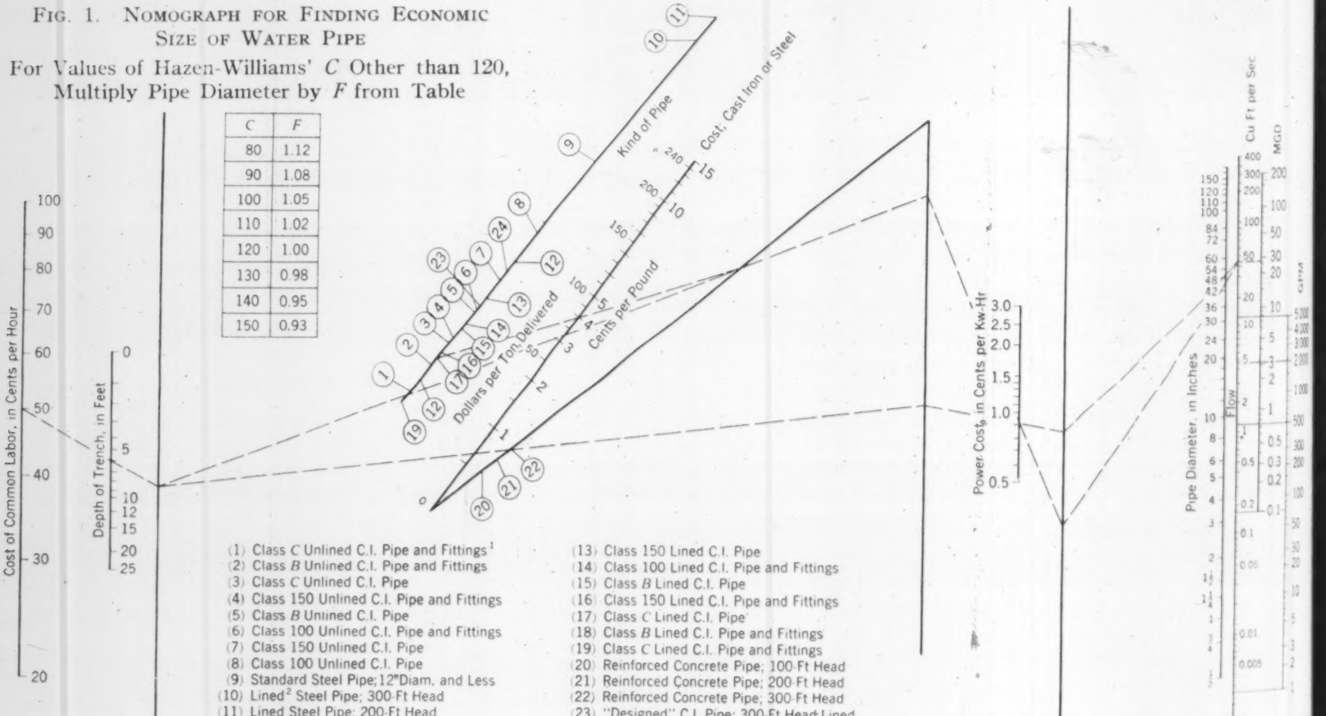
The nomograph has also been checked against installations of reinforced-concrete pressure pipe. The size range of such pipe thus far is from 15 to 150 in.

In the example illustrated on the nomograph, cement lined cast-iron pipe and reinforced-concrete pressure pipe are compared at a discharge of 28 mgd and a working head of 300 ft. The cost of common labor is 50 cents per hr; the average depth of trench, 6 ft; the power cost, 0.9 cent per kwhr; and the cost of cast-iron pipe at the trench, 4 cents per lb. The sizes of concrete and cast-iron pipe are found to be 49 in. and 44 in., respectively. However, as a Hazen-Williams coefficient, C, of 140 instead of 120 might be assumed, we multiply both 49 and 44 by 0.95 and find the economical size of concrete pipe to be 46 in. and the economical size of lined cast-iron pipe to be 42 in.

Additional kinds of pipe may be placed on the nomograph by using the total cost line, which is the reference line adjacent to the "cents per pound" line. As the values on this line are directly proportional to the distance from the origin 0 at the left, if a kind of pipe costs twice as much per foot as its nearest competitor in cast-iron pipe, then its position will be twice as far from the origin as the line cutting the type of cast-iron pipe and its cost per pound. In this way, by comparing the cost of the desired pipe with that of the cast-iron as a yardstick, any selected pipe can be handled on the nomograph.

FIG. 1. NOMOGRAPH FOR FINDING ECONOMIC SIZE OF WATER PIPE

For Values of Hazen-Williams' C Other than 120, Multiply Pipe Diameter by F from Table


Cost of Common Labor, in Cents per Hour
100
90
80
70
60
50
40
30
20
Depth of Trench, in Feet
0
5
10
12
15
20
25
Kind of Pipe
Cost; Cast Iron or Steel
Dollars per Ton, Delivered
50
100
150
200
240
Cents per Pound
0
1
2
3
4
5
10
15
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(15)
(16)
(17)
(19)
(20)
(21)
(22)
(23)
(24)
Power Cost, in Cents per Kw-Hr
3.0
2.5
2.0
1.5
1.0
0.5
Pipe Diameter, in Inches
150
120
110
100
84
72
60
54
48
42
36
30
24
20
10
8
6
5
4
3
2
1 1/2
1 1/4
1
3/4
1/2
Flow
Cu Ft per Sec
400
300
200
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0.005
0.001
MGD
200
100
50
30
20
10
5
3
2
1
0.5
0.3
0.2
0.1
GPM
5000
4000
3000
2000
1000
500
300
200
100
50
30
20
10
5
3
2
1

C	F
80	1.12
90	1.08
100	1.05
110	1.02
120	1.00
130	0.98
140	0.95
150	0.93

(1) Class C Unlined C.I. Pipe and Fittings[1]
(2) Class B Unlined C.I. Pipe and Fittings
(3) Class C Unlined C.I. Pipe
(4) Class 150 Unlined C.I. Pipe and Fittings
(5) Class B Unlined C.I. Pipe
(6) Class 100 Unlined C.I. Pipe and Fittings
(7) Class 150 Unlined C.I. Pipe
(8) Class 100 Unlined C.I. Pipe
(9) Standard Steel Pipe; 12"Diam. and Less
(10) Lined[2] Steel Pipe; 300-Ft Head
(11) Lined Steel Pipe; 200-Ft Head
(12) Class 100 Lined C.I. Pipe
(13) Class 150 Lined C.I. Pipe
(14) Class 100 Lined C.I. Pipe and Fittings
(15) Class B Lined C.I. Pipe
(16) Class 150 Lined C.I. Pipe and Fittings
(17) Class C Lined C.I. Pipe
(18) Class B Lined C.I. Pipe and Fittings
(19) Class C Lined C.I. Pipe and Fittings
(20) Reinforced Concrete Pipe; 100-Ft Head
(21) Reinforced Concrete Pipe; 200-Ft Head
(22) Reinforced Concrete Pipe; 300-Ft Head
(23) "Designed" C.I. Pipe; 300-Ft Head; Lined
(24) "Designed" C.I. Pipe; 200-Ft Head; Lined

[1] Fittings; One Valve, One Tee and One Cross in Every 500 Ft
[2] "Lined" Signifies Cement or Bituminous Enamel Coating

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Reynolds' Number and Manning's *n* Not Functionally Related

TO THE EDITOR: It seems to me that the implications of the article, "Relation of Reynolds' Number **R** to Manning's n" by Robert E. Kennedy, in the February issue, are somewhat misleading. There is no natural relation between Reynolds' number and n, since the Manning formula is a rough conduit formula and is applicable only when the friction factor f, is constant and does not vary with R. The roughness factor n is a characteristic of the channel, and does not vary with viscosity of the fluid, or with the depth of flow or velocity.

Since the so-called Darcy formula is a general relationship, it of course can be used in place of the Manning relationship, in which case we have $\sqrt{8g/f} = 1.486R^{1/6}/n$. It should be noted that the constant $\sqrt{g}$ is implied in the Manning formula, and n has the dimension of a $(\text{length})^{1/6}$ and not "sec.^{3} per ft." In addition, f is dimensionless instead of "ft per sec" (Darcy's formula indicates this without any further proof), and after Eq. 2 the kinematic viscosity should be 1.23×10^{-5}.

The ratio R/n^6 is known as the relative roughness, and thus we note from the above relationship that f is a function only of this ratio, and nothing else, for conditions when Manning's formula is applicable. The author's Eq. 1 is a transformation of the above-mentioned relationship. However, he brings in Reynolds' number by introducing on both sides of his Eq. 1 the velocity and kinematic viscosity and concludes that the Reynolds' number is a function of n. This has absolutely no physical significance, and the contents of this paper beyond Eq. 1 would seem to have no particular physical basis.

A. A. KALINSKE
Research Engineer, Iowa Institute of Hydraulic Research, University of Iowa

Iowa City, Iowa

TO THE EDITOR: Mr. Kennedy's paper entitled "Relation of Reynolds' Number **R** to Manning's n," in the February issue, would seem to show a close interdependence of these two parameters, while in reality they have no such connection. The true Manning n, as is evident from the customary tables for its evaluation, varies with boundary roughness alone, and no change in viscosity, velocity, hydraulic radius, or slope can therefore affect its magnitude. In other words, Mr. Kennedy's Eq. 1, the derivation of which is quite correct, may be written in the dimensionless form

$$f = 117\left(\frac{n^6}{R}\right)^{1/3}$$

The quantity n^6/R represents the relative roughness of the boundary—the ratio of a linear measure n^6 of the roughness to a linear measure R of the flow section. Such combination with the Darcy-Weisbach relationship indicates that the Manning formula and roughness tables apply only to that part of the familiar f-vs-**R** plot in which f is completely independent of **R**.

It is possible, of course, to incorporate **R** in any such expression—but only if this is done without affecting the validity of the expression itself. Mr. Kennedy's Eq. 2 is therefore not incorrect, for cancellation will reduce this relationship to Eq. 1. But Eq. 3 refers to a particular case of arbitrarily chosen velocity and kinematic viscosity, and the nomogram based thereon is directly applicable only in case this velocity and viscosity actually prevail. Thus the seeming dependence of **R** upon n, or vice versa, is due only to the fact that V and ν have been replaced by particular numerical values. Indeed, Mr. Kennedy states that "A nomograph for any velocity and any water temperature may be made by the addition of two more columns to Fig. 1. Such a chart was constructed but it seemed more roundabout to use than to solve the two simple arithmetical operations involved by hand." As a matter of fact, it would seem to the writer simpler to avoid roundabout methods entirely and determine the Reynolds' number from the basic identity $\mathbf{R} = VD/\nu$, for each of these values is known from the start. In the case of fully developed roughness action, neither f nor n can have any bearing upon the result, since they represent interrelationships of s, V, D, and g—but are not controlled by ν.

In this connection it is pertinent to note that the Manning n, although basically applicable to roughness effects alone, is sometimes forced to bear the brunt of viscous influence upon the flow. That is, the value of n is frequently computed from measurements in the zone of transition between smooth and rough boundary action, such results indicating a definite variation of n with the Reynolds' number. This obviously is not compatible with the Manning formula itself, but it is due to improper extrapolation rather than to failure of the empirical relationship in a zone to which it obviously does not apply.

HUNTER ROUSE, Assoc. M. Am. Soc. C.E.

Iowa City, Iowa

Design and Construction of Combat Air Fields

TO THE EDITOR: The article on "Protective Designs for Military Airports" by LeRoy M. Hersum, in the December issue, brings to mind my experience in the design and construction of combat air fields with the A.E.F. in France in 1918. The following notes may assist civilians who are involved with work on army fields.

A commercial airdrome is planned primarily for the efficient handling of passengers and freight and the convenient care of the planes and is designed for publicity. It is located as near a large city as possible. A military air field for war conditions should be planned for efficient handling of the planes and the protection of the material and personnel and should be inconspicuous. It should not be close to a city. In 1918 the maxim was "The best defense against night bombing is night bombing," and today the first objective of invading planes is the hangars and flying fields of the enemy.

The World War proved the advantage of small and scattered airdromes with an admixture of both emergency and dummy fields. The Handley-Pages and Caprones of the Allies in 1918 were nearly as large as the big bombers of today, but the rate of speed of landing has greatly increased for all types. This requires much longer runways. The field should be near a highway for supplies, and the openings of the hangars should face away from the direction of prevailing storms.

Our Air Service in France heard rumors of underground, bombproof German hangars, but after the Armistice none were found. Similar reports with realistic but imaginary drawings, showing hills and concrete controls heaped above the shelters for the planes, are published today. Would not the cost of the concrete slabs or arches to support such loads across hundred-foot clear spans be a waste of essential war materials when one lucky shot at the swinging portals would block all egress. The time element is of great importance.

A depressed hangar, however, backed into a hillside with the excavated soil banked around it would give excellent shelter from bomb splinters to the planes inside, and the chances of a direct hit are small. With such a hangar the entrance could still be set above grade to allow natural drainage from the inside. A newspaper photograph of a "feeder" field recently built by the government in Maine shows the single hangar in the open, though directly behind it is a gentle timbered slope. If the hangar had been recessed in the woods, it would have served as both splinter screen and camouflage.

The favored design for bomb shelters was a horseshoe-shaped trench in sloping ground, with two ends in case one was hit. The trench was open above because piled-up logs and earth would only add to the danger if a direct hit occurred, and was deep enough to avoid splinters even from a bomb landing very near. It was cut into an incline with the floor at the back higher than at the two entrances so that rain or subsoil moisture would drain out. Above all it was easy to install.

Airdromes are extremely easy to photograph from above with a telescope lens. Even in 1918 such prints would disclose all buildings and grounded planes. Painted camouflage was valueless, as at night it did not hide the straight edges and, above all, the straight-edged shadows of buildings. Also, painted camouflage, whether "naturalistic" or the almost universal "patch" type of crude, contrasting colors, fades out in strong sun light at certain angles. Trees close to a building mask its outline and shadows, and branches fastened here and there along the eaves also help. Irregular grouping is invaluable.

CHARLES G. LORING

Boston, Mass. *Former Captain, Air Service, A.E.F.*

The Peary Humpty-Dumpty Lock Gate

TO THE EDITOR: It is a paradox that the Arctic explorer and first discoverer of the North Pole, Admiral Robert E. Peary, got his first taste for, and experience in, foreign exploration in tropical Panama and Nicaragua. Civil engineer A. G. Menocal, of the U.S. Navy, who was a trusted specialist on Isthmian Canal investigations for Presidents Grant, Hayes, and Arthur, secured the detail of Lieutenant Peary (whose examination board Menocal had headed some years before when Peary entered the Navy from civil life).

It was from these two officers' work and reports that it first became established in official circles that a lock-type canal best fitted natural conditions at both Nicaragua and Panama. And it is very possible that Assistant Engineer Peary's unique rolling or tumbling lock gate (as described for Lock No. 3, in Menocal's "Report of the Nicaraguan Survey, 1885") has features well worth studying for possible incorporation into modern lock-gate designs for high and narrow lock or drydock chambers. In his novel use of shifting water ballast to roll or tip his lock gate in a vertical arc into or out of the lock chamber one wonders if Peary had not previously been watching a humpty-dumpty doll.

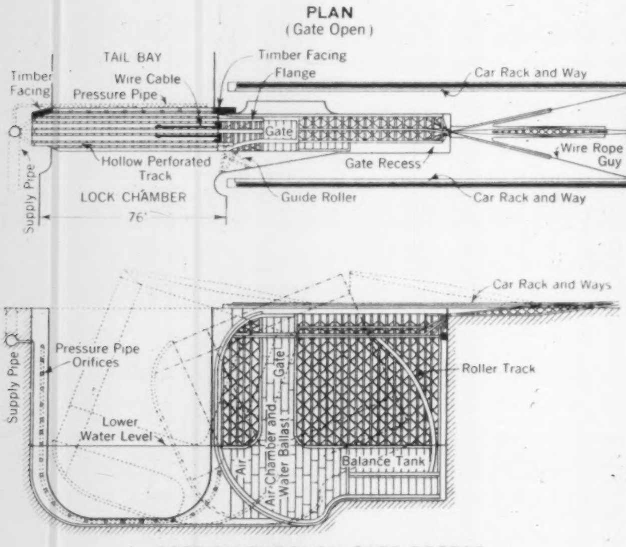


FIG. 1. TUMBLING LOCK GATE

The accompanying illustration (Fig. 1) and description are taken from Senate Executive Document No. 99, 49th Congress, 1st Session, 1885: ". . . . the tailgate of Lock No. 3 (88 ft high, and 58 ft out of water when the lock is empty) requires means for counteracting winds. Lieutenant Peary designed for this a rolling or tumbling gate as follows:

"The gate proper, a lateral recess in one side of the lock chamber, rails upon which the gate travels by rolling, a car spanning the recess and traveling back and forth upon a track laid atop the lock wall, and a rod strut or pivoted truss connecting the car to the gate. The gate has a rectangular upper part resting on a curved lower portion; the inner or rear part of this curve is a quadrant of such radius that the travel of the gate, in rolling through 90 deg, will carry it entirely within the gate recess. The lower part of the gate, to a point one or two feet above the lower water-level, and the inner or rear side of the gate, is a water-tight compartment containing the shifting water ballast. The remainder of the gate is open truss, plated downstream. The center of gravity is maintained by this means, near the center of arc on which the gate rolls, and the balance more perfectly maintained. The gate travels on rails laid above the floor of the lock chamber to prevent drift and mud on their surfaces. Flanges on the curved bottom of the gate prevent lateral movement; any slip forward or backward during gate maneuvering is precluded by four chains, each equal in length to the arc of the rolling quadrant, and arranged in pairs . . . thus when the gate is closed and in the erect position the chains in pair No. 1 are wound upon the periphery of the rolling quadrant, while those in pair No. 2 are lying straight and taut upon the floor of the gate recess; and vice versa . . . ."

It is interesting to note the increasing trend in sizes of ships as shown in the fact that in 1885 Peary was designing permanent locks with 76-ft chambers for caring for world traffic; in 1901 the International Canal Board recommended for the then proposed Panama or Nicaragua locks 95-ft chamber widths, but fortunately the Navy General Board induced President Theodore Roosevelt to have them built 110 ft wide. The Canal Board of 1931, appointed by President Hoover, urged 125-ft widths for the then proposed Nicaragua Canal or the alternative Third Locks System at Panama, but the latter locks, now under construction, are being built 135 ft wide.

Rochester, N.Y. RALPH Z. KIRKPATRICK

Irrigation Projects Economically Sound

TO THE EDITOR: I was interested in Mr. Page's article entitled "The Broad View of Reclamation," in the October issue, and in the subsequent discussion. It should be pointed out that irrigation enterprises are not necessarily costly and they are generally economically justifiable and profitable for the farmers. From an intimate and personal knowledge of the irrigation systems built in Colorado between 1860 and 1900 I cannot recall one that was not profitable to the farmer, and few that were not ultimately profitable to the promoter.

Since 1900 there have been some failures. These failures were due in most cases to poor engineering advice, and in some to lack of quick colonization, to the poor character of the settlers, and to the effect of the war. On the other hand, a number of irrigation projects built by private enterprise have paid in full, though burdened with promotion costs and unsubsidized. In others the debt was refinanced, and the promotional and excessive construction profits were canceled by the issuance of new bonds at 66 per cent of the original amount, which were paid in full.

From forty years of experience, I am certain it can be proved that the losses in irrigation enterprises are no greater than, if as great as, the losses in banks, commercial enterprises, railroads, or utilities. The fact that bond houses, from 1915 to 1929, preferred to handle bonds and stocks of industrial projects, tended to build up a speculative hysteria in these securities and to depreciate irrigation bonds. This accounts for the misapprehension under which the public labors concerning the soundness of irrigation projects.

The theory that the abandonment of farms and reclamation are in economic conflict, and that irrigation aggravates surplus crop conditions, is generally accepted by the public and by those who investigate inadequately and whose experience is limited. The unsoundness of such misapprehensions is discussed in an article by the writer entitled "Rehabilitating the Dust Bowl," which was published in the September 1937 issue of CIVIL ENGINEERING. A reading of this paper is recommended to those interested in the matter of surplus crops, reclamation, rehabilitation, and conservation.

JOHN E. FIELD, M. Am. Soc. C.E.

Denver, Colo. *Consulting Engineer*

Determining the Value of Public Works Expenditures

To the Editor: Very few engineers will oppose the general contention that public works should be justified economically. In fact any expenditure of public funds, whether for public works, or armaments, or the general running expenses of a government, must have economic justification if our nation is to endure. It is, however, one thing to give lip service to the general theory of economic justification and an entirely different problem to get right down to cold hard figures and show justification.

Let us take a simple case, and one which most engineers know is justified, and discover a few of the problems involved in attempting to prove justification from a purely economic viewpoint. Let the case be the justification of the expenditure involved in mapping a quadrangle anywhere in the United States, except where the map is made for the express purpose of some definite project. Let us assume the cost to be \$10,000. In justifying this expenditure the following information will need to be determined:

1. Length of useful life of the map. Many maps made prior to 1890 are still in use and will be for years to come. If the interest rate were 3%, it would be necessary to receive about \$4 benefit now for each dollar spent in 1890.
2. What are the benefits that will accrue to the map during its life? What are the uses to which it will be put, and how much is each worth in terms of dollars? If the map is used by a hiker or fisherman to locate a lake, stream, or mountain in the back country, what is the dollar value? If the map is used by army artillery for the purpose of setting guns for firing at an enemy objective, what is the value? If it is used by a downed aviator for finding his way out of a frozen wilderness and possibly saving his life, what is the value?
3. When are these benefits to accrue? If \$11,000 of benefits accrue to the whole peoples the year the map is made, it would be justified from our economic viewpoint. If, however, no benefit accrued for 49 years it would take about \$44,000 worth of benefits the fiftieth year to justify the original expenditure.

These three questions have to be answered correctly in economically justifying any project. If, for example, a flood control project is analyzed and it is found that for each dollar spent 90 cents worth of benefits will accrue and it is known that several lives will probably be saved and that the anguish and heartaches of many who might otherwise lose their homes and lands will be prevented, who is to say whether or not the project would be justified? Many will claim that the intangible values are worth more to society than are the things upon which dollar values can be placed.

Until such time as we are able to measure quantitatively intangible values it will be humanly impossible to make even a fair guess as to the true value of public works projects, such as flood control, water conservation, highways, and even armaments.

Riverside, Calif. Roger E. Amidon, Assoc. M. Am. Soc. C.E.

Old Beam Tests Accord with "Bundle-Bar" Results

Dear Sir: I have read with considerable interest the article by Homer M. Hadley on "Tests of Beams Reinforced with 'Bundle-Bars,'" which appears in the February issue. It seems to me that the article raises very pertinent questions, which should be given serious consideration.

Around 1903 and 1904, when I was developing methods of design for the Corrugated Bar Company, we made many mathematical analyses of the effect of the moduli of elasticity of steel and concrete on proposed formulas. At that time our designs were based on the elastic limit of the steel, and we sometimes used a factor of safety of two on the dead and four on the live load. The final result of these studies was that, regardless of moduli or strength of the concrete, the design could be entirely predicated on the elastic limit of the steel, assuming of course a decent concrete and provided the reinforcement did not exceed $1^1/_3\%$.

This was in the old days of reinforced concrete construction, when we figured on a compressive strength of from 2,000 to 2,500 lb for the concrete. However, this method of design has always appealed to me as a rational one, and it has been used in a great many structures with success.

The foregoing discussion refers to bending moment only. Shear was taken care of by means of bent-up bars and stirrups. This method was very much in accordance with present-day practice, although we used about 125 lb per sq in. for the concrete's share.

In regard to longitudinal shear, the beam with the paper separator described by Mr. Hadley is very interesting. It recalls some tests, made in 1907 or 1908, when I was with the Unit Construction Company. These tests were made on built-up T-beams, in accordance with the practice of that company. I do not recall the size of the beams, but the span was about 9 ft, and they were designed to break within the 50,000-lb capacity of our testing machine. The schematic cross section is indicated in the accompanying Fig. 1. The cross-hatched part indicates the simple beam. The L-shaped wings on each side represent the end of unit floor slabs, supported by the beam. Directly over the beam there is a grout fill.

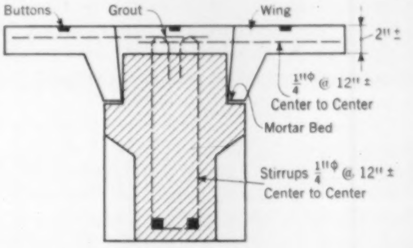


Fig. 1

The grout was the same mix as the beams, though possibly a finer coarse aggregate was used. The wings were placed on mortar beds, three sections to each side of the beam. Steel buttons were placed in the grout and in the middle sections of the wings, 8 in. apart, at mid-span. During the test careful extensometer measurements were taken, and these showed practically identical deformations in the grout and wings. This test is cited, because it has a bearing on the subject of "keys" brought up by Mr. Hadley.

The question of bearing strength is also very interesting, especially if it is based on the strength of 12-in. cylinders, 6 in. in diameter. It is evident that the bearing strength of a given area, which is surrounded on two or more sides by "excess" material, is much greater than if the "excess" material were not there. About thirty years ago the Lemp Brewery made some changes in and additions to a building, which tripled the load on the foundations. It was at first thought necessary to enlarge the steel base plates. Investigation, however, showed that the stone blocks under the steel plates extended about 8 in. or more, outside of the steel, on all sides. After due consideration it was decided to do nothing to the base plates, and the building still stands.

John Conzelman, M. Am. Soc. C.E.
Kirkwood, Mo. *Consulting Engineer*

Analysis of Proposed Engineering Curriculum

To the Editor: If the proposed curriculum, described by Professor Morris in the "Society Affairs" section of the February issue, is to be considered as an attempt to clarify the "Report of the Committee on Aims and Scope of Engineering Curricula," the writer is reluctantly forced to the conclusion that the curriculum may "bring pandemonium out of chaos." A careful study of the percentages reveals a total of 97% for the lower limits and 137% for the upper limits. The writer cannot justify, arithmetically, more than a 3% increase in the lower limit of any one of the subjects listed, unless the lower limits of other subjects are violated, yet six of the subjects have an increase of 3% or greater to the upper limit. Beyond any doubt the upper limit is the "ceiling."

Further consideration of the percentages, by recomputing each column to a base of 100% total, shows a net decrease of 0.6% from the lower to the upper percentages of the Scientific-Technological group, with a corresponding increase of 0.6% for the Humanistic-Social group. This does not appear to constitute a very marked tolerance between the two groups. A far greater adjustment is permitted between the highly technical groups of engineering fundamentals and civil engineering applications than between any other groups.

As a closing comment, the writer is tempted to state that the 137% total of the upper limit is representative of what is attempted at the present time in the four-year curriculum and that the 97% is what we fondly believe is accomplished. The addition of 37% more time to the four-year curriculum produces the mystic figure of five and one-half years.

George C. Ernst, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering,
College Park, Md. *University of Maryland*

Increasing Justification for Public Works Expenditures

TO THE EDITOR: I should like to comment on the article on "Economic Studies for Public Works," by Messrs. Hyatt and Matthew, in the November issue. It is true that in the development of our natural resources private enterprise has achieved creditable results and, on the whole, without undue profit. It is equally true, however, that in the development of these resources, private enterprise has selected the easiest and most attractive projects and depended on a single use for its income. Few such projects are now available, and the time has come when the more difficult and expensive projects must be built. The cost of these is often so great that the revenue from a single use does not justify construction. The following is a case in point based on actual conditions not entirely dissimilar in objective and result from the Central Valley Project.

Two large transcontinental tunnels—the Moffat and the William's Fork—have been built. These carry water from the Western or Pacific slope to the Eastern slope. The water is used primarily for municipal or irrigation purposes, and the first users pay the construction costs. After the first use the water returns to the South Platte River. In the case of irrigation use about 30% returns, and in the case of municipal use about 85%. This return water upon reaching the river becomes, under our laws, a part of the river supply, subject to rediversion and use, and is allocated to the several ditches in accordance with the priority rights. Thus the existing ditches are greatly benefited by the increased supply. After this second use a percentage again returns to the river and is again rediverted and so on until the water has been almost wholly consumed through evaporation and plant transpiration. These secondary beneficiaries pay nothing toward the cost of construction, and it would be very difficult to determine the amount of benefit to the numerous ditches and to the many users of the ditches, or to determine the benefits to the towns for sewage dilution and other uses.

The benefits accrue to the whole watershed of the South Platte River, even to water users in Nebraska, and more remotely, to the state and the nation. Therefore, the secondary users, the towns, the counties, the state, and the nation should in equity participate in the construction cost, and this can best be done by donative aid. Similarly, the development of other hydraulic enterprises and of natural resources benefits all the people directly and indirectly.

In the case of the illustration, it is equitable to distribute the cost on some approximate and practicable basis—for example, the first user 50%, the second user 25%, the watershed 15%, the state 7%, and the nation 3%. The 50% of secondary and general benefits charged on federal aid projects is met by grants, loans at 4%, and waiving of interest, but a more direct participation by the watershed and the state may be advisable even where unemployment is a factor.

Scarcely any development of natural resources results in a single use; multiple use is all but universal, and the benefits accrue in almost infinite variety to many people. With the exhaustion of the simple and cheap possibilities, and with the increase in difficulty and cost of those remaining, private enterprise, if unsubsidized, cannot profit from revenues limited to the one and primary use. Multiple use under private enterprise is possible, but the remote and intangible benefits cannot be assessed by it.

Because of these intangible benefits and the difficulty of determining the equitable distribution of costs to the secondary uses, a subsidy to either private or public enterprise appears to be necessary if these difficult but needed developments are to be undertaken. Subsidizing private enterprise is a remote possibility.

The old method of determining economic feasibility is no longer applicable in most cases, and engineers must consider multiple uses and benefits in the determination of the soundness of an enterprise. In the case of the tunnels mentioned, I find it difficult to estimate the value of a project which, for a thousand years in the future, will enable many families to have a home, a business, and security—not to mention increased taxable values, increased trade, transportation, and communication.

Increase in population is not important, but to furnish people an opportunity to employ their time and talents profitably should be the main objective in the development of natural resources.

JOHN E. FIELD, M. Am. Soc. C.E.
Consulting Engineer

Denver, Colo.

Interpretation of Triaxial Compression Data

TO THE EDITOR: The description of a new method for interpreting data from triaxial compression tests contained in the article by Messrs. Smith and Brown, in the January issue of CIVIL ENGINEERING, is lucid, but the procedure is fundamentally unsound.

It is the rule rather than the exception in the Mohr analysis of triaxial compression data that the envelope is curved. The degree of curvature varies, approximating in some cases a straight line but showing considerable curvature for many soils. The failure to find a common tangent for a group of experimentally determined Mohr stress circles is due in part to the errors inherent in any testing procedure and in part to the fact that the apparent cohesion, C, and the angle of internal friction, ϕ, either one or both, are dependent upon the stress condition which exists in the test specimen. The graphically determined Mohr envelopes thus indicate some particular value of C and ϕ for each Mohr circle, and only in certain cases approximate a single value of C and ϕ for a material. However, the value of $\tan \phi$ is given directly by the slope of the Mohr envelope, and the apparent cohesion, C, is given by the intercept of the envelope on the ordinate of the graph. Thus, where it is possible to approximate a common tangent for a group of Mohr circles these quantities are easily derived from the graph.

The procedure proposed by Messrs. Smith and Brown involves the graphical solution of their Eq. 7—that is,

$$\sigma_1 = 2C\gamma + \gamma^2\sigma_2$$

where $\gamma = \tan \phi + \sqrt{1 + \tan^2 \phi}$.

It is apparent from these equations that only if C and ϕ are constant can a straight line result from plotting the experimental data for σ_1 and σ_2. Should such a straight line be found, determination of the desired values, C and ϕ, would involve determination of the slope of the line which is equal to γ^2 and the intercept on the ordinate which is $2\gamma C$. Further computations are necessary to obtain the values of C and ϕ. However, if the line is straight, the Mohr envelope must necessarily be a common tangent and determination of C and ϕ would be very simple.

In case either C or ϕ or both are not constant, the coefficients of Eq. 7 would be variables and no straight line would result in the graph. Furthermore, if $\tan \phi$ is not constant, the coefficient of σ_1 will vary as the square of $\tan \phi$ so that the curvature of the $\sigma_1 - \sigma_2$ graph will be more pronounced than that of the corresponding Mohr envelope. It should also be noted that despite the scale distortion of 10 to 1 employed in Fig. 4, a line through the plotted points shows a decided curvature.

In view of the fact that both ϕ and C are generally dependent upon the stress condition, the significance of a "most probable" value for these quantities is doubtful except in the case of common tangent envelopes for the Mohr circles.

In comparison with the Mohr stress analysis, the new method of interpretation compounds experimental errors, involves much more complicated processes of analysis of the data, and achieves its objective only through the unjustifiable assumption of a constant angle of internal friction and a constant apparent cohesion.

WILLIAM R. PERRET

Vicksburg, Miss.

Flag Etiquette

TO THE EDITOR: On page 803 of the December number of CIVIL ENGINEERING you have a scene at the annual banquet of the Mid-South Section.

It appears to me that the American flag is not hung in the proper way. This may be an optical illusion, but I am sure that in times like these many more like myself will notice the flag.

An explanation of the etiquette for displaying the flag would be appreciated.

Long Beach, Calif. J. E. SOLEM, Assoc. M. Am. Soc. C.E.

[*Editor's Note:* The field should hang at the "flag's own right." In this instance the flag should have been regarded as facing the audience and was therefore incorrectly oriented.]

SOCIETY AFFAIRS

Official and Semi-Official

Baltimore Prepares Welcome

Society's 1941 Spring Meeting to Be Held in Maryland, April 23–25

After nearly 27 years, Baltimore will again be host to the Society at one of its national meetings. The earlier meeting in Baltimore in 1914 set a high standard for interest and entertainment, and the present committee is striving to maintain the city's reputation for southern hospitality. At least one feature of the earlier meeting, which loses none of its fascination with the passage of time, will be repeated—a boat trip to historic Annapolis, and a visit to the U.S. Naval Academy there, will again be a major social event.

While the Baltimore Committee has in characteristic fashion given every consideration to its social program for both members and their ladies, it has at the same time produced an exceptionally interesting schedule of technical sessions and inspection trips. Seven Divisions will hold half-day sessions; these will offer such a wide variety of subjects for discussion that practically every civil engineer and many engineers in related fields will find some technical reason to justify attendance. The committee is not greatly concerned with what particular feature of the meeting accounts for a member's presence—it simply guarantees that those who do come will enjoy every minute of their stay.

Headquarters for the meeting will be the Lord Baltimore Hotel, where all the sessions, except those of the Student Conference, will be held. The dinner and dance, following traditional practice, will be held on Wednesday evening in the hotel ballroom.

Two short general sessions are planned; quite naturally the theme will be the resources of the Chesapeake Bay area. Appropriately, its seafood will be enjoyed on the trip to Annapolis, and a general session on the boat will be devoted to the problems of conserving this natural resource, which has contributed much to the fame of the state. The principal inspection trip will be made by fast electrified train to the hydro plants on the Susquehanna River. Opportunities will also be provided for individual or group inspection trips to engineering projects, industrial plants, and points of cultural and historic interest in and near Baltimore.

There follows a brief outline of the program—technical sessions, inspection trips, and social events. More complete details, including time schedules, will be published in the April issue.

Technical and General Sessions, April 23–24

Wednesday Morning

General Session

Resources and Possibilities of the Chesapeake Bay Area

Wednesday Afternoon

Engineering Economics Division

Transportation of Tomorrow
Relative Economy and Distinctive Functions of the Different Means of Transportation

Highway Division

Military Roads
National Defense Highways Through Maryland
Driver Behavior and Vehicle Performance

Structural Division

Unusual Design and Erection Problems in Aircraft Plant Expansion
Model Analysis—Susquehanna River Bridge
Roofs Over the House and Senate Chambers of U.S. Capitol
Baltimore Airport

Waterways Division

Determination of Benefits Accruing from the Construction of Flood Control Works
The Drainage of Leveed Areas in Mountainous Valleys
The Toby Creek Pressure Conduit
Pumping Problems Related to Flood Control

Thursday Morning

Power Division

Regional Power Supply of the Chesapeake Bay Area
Power Planning in the Tennessee Valley Authority
Financing of Power Projects

Sanitary Engineering Division

The Activated Sludge Works at Baltimore, Md.
Water and Sewerage Problems of Washington Suburban Sanitary District
Pollution Abatement in the Chesapeake Bay Region

Construction Division

Potomac River Bridge at Ludlow Ferry
National Defense Construction Work
Novel Construction of a Large Venturi Meter

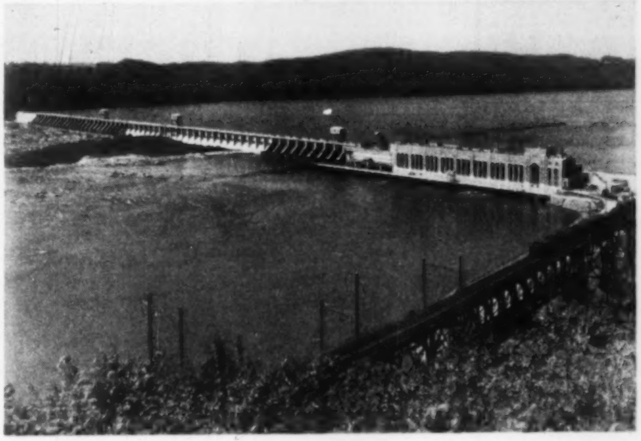
During Boat Trip to Annapolis

General Session

Conservation of Chesapeake Bay Resources

Attractive Inspection Trips Planned

Plans call for a half-day trip on Thursday for members and ladies by special Pennsylvania Railroad electric train to hydro plants on the Susquehanna River. En route may be seen the Glenn L. Martin factory, the Edgewood Arsenal, the new Susquehanna River Bridge, and the Conowingo hydroelectric plant. A brief stop will be made at Holtwood, where the members may inspect the hydro station, the hydraulic laboratory, the unique river coal recovery plant, and the steam station. Others may wish to see an interesting collection of Indian relics, many of them gathered from nearby sites of ancient villages. At Safe Harbor, where the two groups again meet, the visitors may inspect the project and see the exhibits that have made this plant a veritable technical museum. A buffet meal will be served here through the courtesy of the Safe Harbor Water Power Corporation.



Inspection Trip Objective at the Spring Meeting
Safe Harbor Hydroelectric Plant, Susquehanna River

Other inspection trips have been arranged on a very flexible basis. On application of individuals or groups, transportation and introductions or guides will be provided to nearby projects concerning water supply, sewage disposal, airport, harbor, flood control, power, steel manufacturing, and other activities.

Trips to points of historical and cultural interest will be arranged on a somewhat similar basis. No one will want to miss seeing

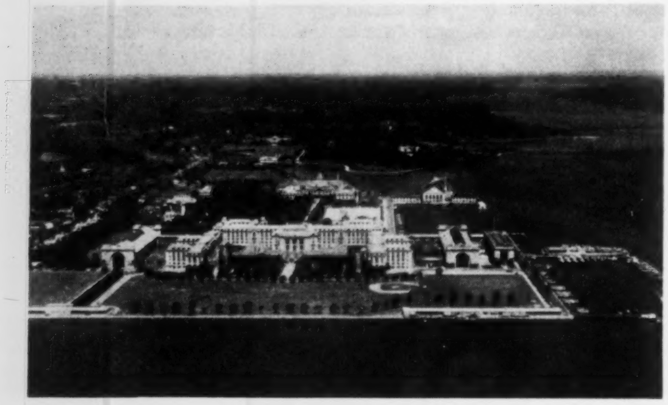
Fort McHenry National Park (the birthplace of "The Star Spangled Banner"), Washington's Monument, the Peabody Library, the Baltimore Museum of Art, and, if time permits, many other historic shrines and museums. Special arrangements will be made for the ladies to visit these places.

SOCIAL EVENTS OF SPECIAL INTEREST

The social program will begin on Wednesday morning, April 23, with the one event reserved exclusively for the ladies. Following registration, the ladies may assemble at their convenience at the Walters Art Gallery, which is not more than five minutes' walk from the hotel. Between 11 a.m. and noon, several lecture tours of this internationally famous gallery will be conducted by the curators. The visiting ladies will here meet members of the local ladies committee, who will take them by private automobile to the Baltimore Country Club for lunch.

Following lunch, bridge and golf will be available to those who care to stay at the club; the others will be taken on a trip about the city with visits to Fort McHenry, museums, parks, and several other points of cultural and historic interest. That evening the previously mentioned dinner and dance will be held at the Lord Baltimore Hotel.

The boat trip to Annapolis on Friday will be the featured event of the program. Both luncheon and supper will be served to those taking this trip; Chesapeake Bay seafood will occupy a prominent place on the menu. In Annapolis may be seen the U.S. Naval Academy, the Maryland State House (in the Senate Chamber of which George Washington resigned his commission in 1783); St. John's College (one of the oldest colleges in the United States), and several Colonial homes which have been restored and opened to the public. On the return trip an orchestra on board will provide entertainment and music for dancing.



U.S. NAVAL ACADEMY AT ANNAPOLIS
To Be Visited During Baltimore Meeting

OTHER MEETINGS AND CONFERENCES

Preceding the Meeting proper, a Local Sections Conference will be held on Tuesday, April 22. The Student Conference will meet at the Johns Hopkins University on Wednesday, April 23, concurrent with the first day of the Meeting. The students are invited to attend the various events on Thursday and Friday. The Board of Direction and its committees will meet on the Sunday, Monday, and Tuesday preceding the Meeting.

As this Society meeting comes in the midst of the racing season in Maryland, it will be advisable to make hotel reservations early. On Saturday, April 19, there will be a run near Hereford, Md. (about 20 miles from Baltimore), the famous Grand National, and the Churchville Cup. On Saturday, April 26, the Maryland Hunt Cup Race, featured in the recent popular movie "Maryland," will be run in the Worthington Valley. These amateur point-to-point races are internationally known and have a long background of tradition. They annually attract thousands of spectators and the attention of sportsmen throughout the world. In addition to these timber races on Saturday, there is professional racing daily at Havre de Grace, one of Maryland's well-known tracks.

All ages, all tastes, all inclinations will find enjoyment and interest at the Baltimore Meeting. Mark the dates—Wednesday to Friday, April 23–25, 1941.

Meeting of the Outgoing Board of Direction—Secretary's Abstract

ON JANUARY 13 and 14, 1941, the outgoing Board of Direction met at Society Headquarters with all members present: President John P. Hogan in the chair; George T. Seabury, Secretary; Past-Presidents Riggs and Sawyer; Vice-Presidents Ferebee, Davis, Jacobs, and Lucas; and Directors Agg, Anderson, Ayres, Blair, Bres, Brooks, DeBerard, Dunnells, Goodrich, Harrington, Hudson, Hyde, Leeds, Lewis, Parker, Polk, Root, Sawin, and White.

Also present, by invitation, were the members of the incoming Board as observers, that they might gain some insight into the problems they would face in the coming year as officers of the Society.

Annual Report

After review, the Annual Report of the Board was approved as submitted for printing and distribution. This report will appear in full in the 1941 Yearbook, to be issued as Part 2 of the April PROCEEDINGS.

By-Laws Revised

(*a*) Following previous notice of proposed amendments, a rewording of the By-Laws in Article V, Section 4, "Student Chapters," was adopted. It provides that the Annual Report of Student Chapters shall be made "not later than June 15 of each year" instead of "not later than the last day of May. . . . ."

(*b*) Following previous notice in accordance with requirements, the By-Laws were amended in Article IV, Section 1, by adding to the Standing Committees, a "Committee on Society Relationships." Details are given on another page.

Limits of Districts and Zones

Following recommendation of its Committee on Districts and Zones, the Board approved of the existing boundaries of Districts and Zones, without change for the year 1941.

Local Section Constitutions

Revision of the by-laws of the Kansas Section and of the constitution and by-laws of the Northeastern Section was approved.

Engineering Societies Personnel Service, Inc.

The details of the establishment of the Engineering Societies Personnel Service, Inc., to take over the activities of the former Engineering Societies Employment Service, were approved.

Spring Meeting, 1942

Upon invitation of the Louisiana Section, endorsed by the Texas and Mid-South Sections, the Board decided to hold the Society's 1942 Spring Meeting at New Orleans, La.

New Student Chapter

As recommended by the Committee on Student Chapters, approval was given to the formation of a Student Chapter of the Society at the University of Connecticut.

Rules for Daniel W. Mead Prize

The Committee on Professional Conduct recommended, and the Board adopted, provision that the subjects of papers for the Daniel W. Mead Prizes be selected each year in advance for the succeeding year. Subjects for 1941 were announced, as given in the February issue, page 125.

Railroad Division

Completing consideration of a matter which has been before the Board for a year or more, it was decided not to establish a Railroad Division, as earlier suggested.

State Systems of Plane Coordinates

The Board adopted a resolution commending the establishment of State Systems of Plane Coordinates, as given elsewhere in this issue in full.

Professional Objectives

Special recommendations of the Committee on Professional Objectives were adopted, providing for (1) establishment of a "Committee on New Members"; (2) study of a possible expansion of membership in the grade of Affiliate; and (3) cooperation upon request with state highway departments looking toward improvement of low salaries.

Registration

Four recommendations of the Committee on Registration of Engineers were adopted as detailed in a separate item in this issue.

Membership

As is customary at each Board Meeting, the Board gave careful consideration to many applications for admission and transfer as recommended to it by the Committee on Membership Qualifications.

Professional Conduct

The Board heard and acted upon the recommendations of its Committee on Professional Conduct with respect to certain cases of alleged unprofessional conduct.

Miscellaneous

A variety of matters having to do with routine conduct of business and also with the completion of the year's work of the Board were presented, with appropriate action in each case. Some questions were referred to the incoming Board for additional study.

Budget for 1941

A budget of expected income and proposed appropriations, as recommended by the Executive Committee, was presented. As a result of discussion, changes were adopted in a few items, after which the budget was recommended for approval by the incoming Board.

Adjournment

After distribution of certificates to members whose terms were expiring, and other concluding formalities, the 1940 Board of Direction adjourned.

Meeting of the Incoming Board of Direction—Secretary's Abstract

The Board of Direction met at Society Headquarters on January 16, 1941, with President Frederick H. Fowler in the chair; and present George T. Seabury, Secretary; Past-Presidents Sawyer and Hogan; Vice-Presidents Lucas, Burdick, and Stevens; and Directors Blair, Bres, Brooks, Carey, Cunningham, Dunnells, Goodrich, Howard, Hudson, Hyde, Massey, Requardt, Sawin, White, and Wiley.

Collaboration with Other Professional Organizations

A report was presented from a joint committee on which the Society was represented, covering "Division of Responsibilities and Work Among the Planning Professions of Architecture, Civil Engineering, Landscape Architecture, and Mechanical Engineering on National Defense Housing Projects." After discussion, that statement was approved as a general guide on defense housing projects. Provision was also made for continuation of this joint work. For details see separate article on another page.

Budget

Recommendations of the outgoing Board for the 1941 budget were presented and discussed. The budget was then adopted without amendment, providing a balanced set-up, with a small surplus of income over appropriations.

New Society Committees

Recommendations of the President were confirmed, by approval of the personnel of the following committees:

Executive Committee: Frederick H. Fowler, *Chairman;* George L. Lucas, *Vice-Chairman;* John P. Hogan, Donald H. Sawyer, Joseph Jacobs, Charles B. Burdick, and Charles H. Stevens.

Committee on Honorary Membership: Frederick H. Fowler, *Chairman;* John P. Hogan, Donald H. Sawyer, Joseph Jacobs, George L. Lucas, Charles B. Burdick, and Charles H. Stevens.

Committee on Districts and Zones: Harold W. Hudson, *Chairman;* Charles Gilman Hyde, Sanford W. Sawin, Clarence M. Blair, and John W. Cowper.

Committee on Professional Conduct: Charles T. Leeds, *Chairman;* Edward S. Bres, Armour C. Polk, Clarence M. Blair, William N. Carey, and Gustav J. Requardt.

Committee on Publications: Harold M. Lewis, *Chairman;* Charles T. Leeds, Lazarus White, Clifford G. Dunnells, and Ralph B. Wiley.

Committee on Membership Qualifications: Edward S. Bres, *Chairman;* Robert B. Brooks, Ernest P. Goodrich, Charles Gilman Hyde, John W. Cunningham, and George B. Massey.

Committee on Division Activities: Joseph Jacobs, *Chairman;* Charles B. Burdick, Harold M. Lewis, E. E. Howard, and Armour C. Polk.

1940 Board of Direction of the Society

Starting at the near corner of table and proceeding clockwise: Glenn L. Parker, Director, District 12; Thomas R. Agg, Director, District 16; Arthur W. Harrington, Director, District 3; Henry E. Riggs, Past-President; L. E. Ayres, Director, District 7; J. E. Root, Director, District 9; H. W. Hudson, Director, District 1; Joseph Jacobs, Vice-President, Zone IV; E. P. Goodrich, Director, District 1; Clarence M. Blair, Director, District 2; George L. Lucas, Vice-President, Zone I; Sanford W. Sawin, Director, District 4; Lazarus White, Director, District 1; Clifford G. Dunnells, Director, District 6; Robert B. Brooks, Director, District 14; Charles T. Leeds, Director, District 11; Edward S. Bres, Director, District 15; Harold M. Lewis, Director, District 1; Armour C. Polk, Director, District 10; Charles G. Hyde, Director, District 13; Carolina Crook, Secretary to Mr. Seabury; George T. Seabury, Secretary; Donald H. Sawyer, Past-President; John P. Hogan, Past-President; James A. Anderson, Director, District 5; W. W. de Berard, Director, District 8; James L. Ferebee, Vice-President, Zone III; and R. P. Davis, Vice-President, Zone II.

COMMITTEE ON RETIREMENT SYSTEM: William J. Shea, *Chairman*, term ending January 1944; Lazarus White, term ending January 1943; and Carl E. Beam, term ending January 1945.

COMMITTEE ON SECURITIES: Malcolm Pirnie, *Chairman;* George L. Lucas, and Ralph R. Rumery.

COMMITTEE ON LOCAL SECTIONS: John T. L. McNew, *Chairman*, term ending January 1942; William M. Spann, term ending January 1943; Hal H. Hale, term ending January 1944; Francis H. Kingsbury, term ending January 1945; and Charles T. Leeds, *Contact Member*.

COMMITTEE ON JUNIORS: E. Warren Bowden, *Chairman*, term ending January 1942; Oliver C. Reedy, term ending January 1943; Frank V. Ragsdale, term ending January 1944; C. A. Mockmore, term ending January 1945; and Clifford G. Dunnells, *Contact Member*.

COMMITTEE ON STUDENT CHAPTERS: John H. Porter, *Chairman*, term ending January 1942; Edgar M. Hastings, term ending January 1943; Clarence L. Eckel, term ending January 1944; Frank W. Stubbs, Jr., term ending January 1945; and Charles Gilman Hyde, *Contact Member*.

COMMITTEE ON ENGINEERING EDUCATION: Thomas C. Adams, *Chairman*, term ending January 1942; Louis S. LeTellier, term ending January 1943; James A. Anderson, term ending January 1944; N. W. Dougherty, term ending January 1945; and Ralph B. Wiley, *Contact Member*.

COMMITTEE ON REGISTRATION OF ENGINEERS: William C. E. Becker, *Chairman*, term ending January 1942; Lewis M. Martin, term ending January 1943; T. Keith Legaré, term ending January 1944; H. M. Jones, term ending January 1945; and Armour C. Polk, *Contact Member*.

COMMITTEE ON FEES: Louis R. Howson, *Chairman*, term ending January 1944; L. H. Nishkian, term ending January 1942; H. D. Mendenhall, term ending January 1943; Edward N. Noyes, term ending January 1945; Clarence McDonough, term ending January 1946; and Clarence M. Blair, *Contact Member*.

COMMITTEE ON SALARIES: Dean G. Edwards, *Chairman;* Wilford W. DeBerard, Thomas R. Edmonston, Donald H. Sawyer, Charles S. Shaughnessy, Thomas E. Stanton, and Harold W. Hudson, *Contact Member*.

COMMITTEE ON PROFESSIONAL OBJECTIVES: Robert B. Brooks, *Chairman*, term ending January 1942; Ivan C. Crawford, term ending January 1942; Henry L. Fruend, term ending January 1942; Clifford G. Dunnells, term ending January 1943; A. M. Rawn, term ending January 1943; G. J. Requardt, term ending January 1944; and N. E. Lant, term ending January 1944.

COMMITTEE ON TECHNICAL PROCEDURE: Joseph Jacobs, *Chairman;* Charles B. Burdick, Harold M. Lewis, E. E. Howard, Armour C. Polk, all members of the Committee on Division Activities; also Harland Bartholomew, Chairman, City Planning Division; H. O. Locher, Chairman, Construction Division; E. B. Black, Chairman, Engineering Economics and Finance Division; R. W. Crum, Chairman, Highway Division; Fred C. Scobey, Chairman, Hydraulics Division; S. T. Harding, Chairman, Irrigation Division; William P. Creager, Chairman, Power Division; Arthur D. Weston, Chairman, Sanitary Engineering Division; Carlton S. Proctor, Chairman, Soil Mechanics and Foundations Division; Shortridge Hardesty, Chairman, Structural Division; William N. Brown, Chairman, Surveying and Mapping Division; W. G. Atwood, Chairman, Waterways Division.

COMMITTEE ON SOCIETY RELATIONSHIPS: Charles B. Burdick, *Chairman;* A. C. Polk and Harold M. Lewis.

COMMITTEE ON NEW MEMBERS: Charles H. Stevens, *Chairman;* Edward S. Bres, William N. Carey, H. W. Hudson, and Charles Gilman Hyde.

MEETING COMMITTEES:

Annual Meeting: George L. Lucas, *Chairman;* Harold W. Hudson, Harold M. Lewis, Ernest P. Goodrich, and Lazarus White.

Spring Meeting (Baltimore): Charles H. Stevens, *Chairman;* Sanford W. Sawin, Clifford G. Dunnells, Armour C. Polk, and Gustav J. Requardt.

Annual Convention (San Diego): Joseph Jacobs, *Chairman;* Charles T. Leeds, Charles Gilman Hyde, Edward S. Bres, and John W. Cunningham.

Fall Meeting (Chicago): Charles B. Burdick, *Chairman;* Robert B. Brooks, William N. Carey, George B. Massey, Ralph B. Wiley, Ernest E. Howard, John W. Cowper, and C. M. Blair.

Board Routine

Details of general procedures and conduct of Board work were discussed for the benefit of new members.

Adjournment

The Board adjourned to meet at Baltimore, Md., on April 21, 1941.

Construction Division Expansion

Quartermaster Corps Organizes for Enlarged Program

NOTWITHSTANDING the record of getting 230 projects under construction since June 1, 1940, for equipping, housing, and training 1,400,000 troops under the national defense program—a record of a billion and a quarter dollars of expenditure—the Construction Quartermaster is preparing for a still larger construction program in 1941. Brehon B. Somervell, M. Am. Soc. C.E., Brigadier General, U.S. Army, recently assigned as Chief of the Construction Division, has selected Col. W. B. Styer, Corps of Engineers, as his Executive Officer and Maj. C. F. Robinson, Corps of Engineers, as Control Officer.

The Construction Division's work has been separated into five branches: an Engineering Branch, headed by Col. E. H. Leavey, C.E.; an Operations Branch, headed by Col. L. R. Groves, C.E.; an Administration Branch, headed by Col. J. W. Younger, Q.M.C.; a Finance Branch, headed by Col. W. A. Pashley, Q.M.C.; and a Real Estate Branch, headed by Col. R. D. Valliant, Q.M.C.

The Engineering Branch is charged with the general planning and preparation of contracts for authorized projects. Continuing the present practice the engineering and architectural service will be furnished either by engineers and architects in private practice or by the Branch itself, whichever appears to be in the best interests of the Government. The Engineer-Architects are selected and their work supervised by this Branch.

The Operations Branch is charged with the supervision of the execution of all work by contractors on construction projects, including the inspection of such work for compliance with plans and specifications. Constructing Quartermasters are selected by this branch. Construction cost accounting and the production of cost data is one of the duties of the Operations Branch.

CIVILIAN EXPERTS SELECTED

In the Engineering Branch a Design Section has been set up, with Maj. Hugh J. Casey, M. Am. Soc. C.E., as Chief of Design. Several outstanding leaders in the field of engineering and architecture have been appointed by General Somervell to head corresponding units in the Design Section. Frederick H. Fowler, President, Am. Soc. C.E., is Chief of the Civil Engineering Unit; with E. B. Black, M. Am. Soc. C.E. assisting him on water supply; Samuel Greeley, M. Am. Soc. C.E., on sewerage and incineration; A. D. Taylor on site planning; F. S. Poorman on highways and drainage; and C. E. Goldsmith on fire protection. Edwin Bergstrom, president of the American Institute of Architects, is Chief of the Architectural Unit, with R. H. Shreve as his assistant. Warren McBryde, immediate past-president of the American Society of Mechanical Engineers, becomes Chief of the Mechanical Engineering Unit, and Maj. Howard A. Starret is head of the Research Unit.

It appears to be the intention to award contracts for engineering design and supervision on a negotiated cost-plus-fixed-fee basis as in the past. The units headed by President Fowler and other civilian engineers will assist the engineering firms engaged by the Construction Division by standardizing and coordinating the designs and plans, and the execution of the construction work.

ANTICIPATING FUTURE PROGRAM

The current program of the Construction Division is expected to be completed on schedule by June 1, 1941, in spite of bad weather, labor shortages, and the difficulty of obtaining needed building material and equipment. Cantonment and camp construction is expected to be expanded during 1941 so as to provide facilities for housing and training an army of 3,000,000 men, more than double present Congressional authorizations, and it is probable that the dollar cost of defense construction will exceed $2,000,000,000.

Professional Collaboration on National Defense Housing Projects

The National Defense Program has required that much of the nation's man power be shifted and concentrated at points of defense activity. Industrial workers and enlisted personnel require housing facilities for their families. To alleviate the shortages in living facilities within the defense areas, the Government has embarked on a program to supply the needed housing. It is being financed either by (1) private capital, (2) by Government loans to private initiative, or (3) by direct Government construction.

Thus far, Congress has provided upward of $300,000,000 for direct construction; 54,000 housing units are now under construction or are completed; and an additional $150,000,000 has been requested of the present Congress. The magnitude of the entire program may be visualized by the presently known shortage of 200,000 housing units, which would cost on the average $3,500 each—a total of nearly three-quarters of a billion dollars.

In an effort to be of maximum assistance to the Government in the construction of these defense housing projects, representatives of the American Society of Civil Engineers, the American Institute of Architects, the American Society of Mechanical Engineers, and the American Society of Landscape Architects have been recently studying how the combined services of the members of these planning professions can best be utilized to assist the Government in obtaining the necessary speed and efficiency. The conclusion has been reached that these results can be obtained by the employment, under a lump-sum or cost-plus-fixed-fee form of contract, of qualified architects, civil engineers, mechanical engineers, and landscape architects resident in, or readily accessible to, the project to collaborate in furnishing design services and in supervising construction.

A study of this collaborative procedure has resulted in the development of a statement which outlines the respective responsibilities and duties of each of the professions when engaged on such a project. The statement is entitled "Division of Responsibilities and Work Among the Planning Professions of Architecture, Civil Engineering, Landscape Architecture, and Mechanical Engineering on National Defense Housing Projects." In January 1941, it received the approval of the governing bodies of the American Society of Civil Engineers, the American Institute of Architects, the American Society of Mechanical Engineers, and the American Society of Landscape Architects for use as a general guide for correctly stating the duties to be performed by each collaborator and by the collaborators as a group. The "Division of Responsibility" may also be used for determining the amount of fees due each of the collaborators.

The statement of the "Division of Responsibility," as approved by these four societies, appears below under a separate heading. The statement is the result of a long series of conferences participated in by the professions and is their first attempt to reach an agreement as to how their work and responsibility should be divided on housing projects.

In continuation of the development of the collaborative procedure, the societies are now engaged in developing a contract form and a schedule of fees that would be appropriate for each of the professional services to be rendered.

Division of Responsibilities and Work

Among the Planning Professions of Architecture, Civil Engineering, Landscape Architecture, and Mechanical Engineering on National Defense Housing Projects

REPORT OF A JOINT COMMITTEE INCLUDING REPRESENTATIVES OF THE SOCIETY

Every housing project built under the National Defense Program should be functionally, if not physically, related to its neighboring communities and should promote the ultimate welfare of those communities. It should be properly integrated with them as to site and permanence of structure and as to transportation, educational, recreational, sanitary, and other facilities. The study of this integration is the normal function of the City Planner.

Each project should provide adequate and appropriate shelters for those who are to occupy its dwellings and adequate and appropriate spaces and facilities to ensure their normal health and well being. The planning of such sites, facilities, and shelters and the supervision of their construction have long been the responsibilities of architects, engineers, and landscape architects in private practice, each performing his respective services on the project.

It is the opinion of the planning professions represented by The American Institute of Architects, the American Society of Civil Engineers, the American Society of Landscape Architects, and the American Society of Mechanical Engineers that their combined services are essential particularly in respect to Defense Housing and that by the employment of their professions in collaboration, the greatest advantage will accrue to the Government.

This statement sets forth, to the extent practicable, the respective responsibilities of these four professions on any collaborative undertaking on National Defense Housing Projects.

It is not the intention to preclude any collaborator from performing any of the services of the other collaborators if he is qualified or competent to do so and if he normally performs such services by means of qualified and competent employees. Nor is it the intention that the divisions of responsibility and work as set out shall be inflexible; they should be used as guides for determining the proper divisions of work for a particular project, because the work to be done by each collaborator may differ in detail in the various projects.

The collaborative services may be performed under a single contract, a joint contract, or under separate contracts with each of the collaborators. All such contracts shall recite and include this full statement of "Division of Responsibilities and Work." The Coordinating Authority and the extent of his authority shall be stated in the contract of employment. In housing projects, the architect normally should be the Coordinating Authority.

JOINT RESPONSIBILITY OF THE COLLABORATORS

The site having been determined, it shall be the joint responsibility of the collaborators to prepare and present to the employing governmental agency a report containing their preliminary estimates of costs and recommendations for the project, for its approval and acceptance.

The collaborative work and responsibility should cover the following fundamental features with respect to the site and the development of the project:

(*a*) Determination of traffic circulation; arrangement, width, and controlling grades of streets and alleys; railway trackage location.

(*b*) Determination of amount of land coverage, general locations of buildings, and general use of open areas.

(*c*) Determination of controlling grades on the open areas and the general elevations of proposed first and basement floors of buildings.

(*d*) Determination of general character of proposed landscape developments.

(*e*) Determination of general locations and types of utility and building services, street signs, fire hydrants, and project lighting (poles, light standards, and conduits).

(*f*) Determination of general character and list of drawings and specifications, to eliminate duplication and to produce efficiency and economy of design and construction.

INDIVIDUAL RESPONSIBILITIES AND DUTIES OF EACH COLLABORATOR

1. *The Architect*

(*a*) shall design, prepare drawings and specifications and supervise construction of all housing units and buildings to be used for community purposes.

(*b*) shall plan the architectural treatment of all other structures or parts thereof, except those specifically excluded by mutual agreement in advance among the collaborators.

(*c*) shall direct the services of mechanical engineers engaged on the mechanical work in buildings.

(*d*) shall direct the services of civil engineers where such services are required on structural and foundation problems of buildings and walls incident thereto.

2. *The Civil Engineer*
   (*a*) shall make surveys for, and prepare all property, topographic and public utility maps.
   (*b*) shall prepare plans for general grading and excavations for engineering developments unless otherwise mutually agreed upon among the collaborators.
   (*c*) shall design, prepare drawings and specifications for, and supervise the construction of domestic water supply systems, sewerage systems, storm drainage systems, yard lighting facilities, heating mains, gas mains, and electrical transmission lines outside of the buildings.
   (*d*) shall design, prepare drawings and specifications for, and supervise the construction of public streets and alleys and such private drives as are included by mutual agreement among the collaborators, including paving, sidewalks, curbs, culverts, retaining walls and bridges incident thereto.
   (*e*) shall design, prepare drawings and specifications, and supervise construction of such foundations and structural parts of buildings and other structures as are, by reason of unusual conditions, not customarily designed by the architect.
   (*f*) shall set lines and grades for control of all work of the project other than for buildings.
3. *The Landscape Architect*
   (*a*) shall determine specific use and arrangement of land areas within the project based upon the general plan adopted for the project.
   (*b*) shall design, prepare drawings and specifications for, and supervise construction of lawns, interior walks and terraces, service areas, parking areas, fences, lawn irrigation and drainage, planting, pools, such other site surface improvements and such private drives as are included by mutual agreement among the collaborators.
   (*c*) shall prepare grading plans and specifications for, and supervise construction on all areas under landscape development unless otherwise mutually agreed upon among the collaborators.
   (*d*) shall design, prepare drawings and specifications for, and supervise construction of outdoor recreation areas, facilities and structures incident thereto, and all walls incident to the landscape development.
4. *The Mechanical Engineer*
   (*a*) shall design, prepare drawings and specifications for, and supervise the construction of central heating and steam power plants, service utilities in the buildings, such as mechanical, electrical, heating, ventilating, air conditioning, refrigerating, plumbing, gas and other services, and all facilities and equipment therefor.

Hydraulic Laboratory Developments Along the Eastern Seaboard

FREE OUTFALL, boundary layers flood waves, density currents, and the design of vegetal channels are among the subjects that Haywood G. Dewey, the Society's Freeman Scholar for 1940–1941, reports are under active investigation in various laboratories he has visited in recent weeks.

At New York University, experiments are being made on the free outfall from circular conduits. Such experiments have direct application to the sanitary engineering field, and relate to leaping weirs at outfall sewers. Measurements are taken of the nappe at the outfall of 4, 8, and 12-in. horizontal transite pipes flowing partly full, to determine the relation between the brink depth and the critical depth for a given discharge. Curves are then plotted permitting the discharge to be determined for a certain brink depth and size of pipe.

Studies now being made on the broad-crested weir at Columbia University, instead of dealing primarily with determining values of discharge coefficients, treat the influence of the physical characteristics of the flow upon such values. Observations are made of the flow forms over the weir and at its downstream end, with and without aeration of the nappe, particular attention being paid to the ratio of the depth of flow at the end of the weir to the critical depth. Submergence is also investigated to find out when it begins, what the water surface is like for different conditions of submergence, what the coefficients are, and what the effect of submergence is upon them. In addition to this study, an investigation has been made of the boundary layer in broad-crested weirs. Velocity measurements were taken along the weir as close to the bottom as possible, the upper limit of the boundary layer being taken at the point where the velocity becomes nearly uniform.

A new hydraulic laboratory has recently been completed at the University of Connecticut. Located in a wing of the new engineering building, it occupies one-half of the civil engineering laboratory, which is 60 by 100 ft in plan. The water system in the hydraulic laboratory is of the recirculating type, with two pumps, one rated at 350 gpm and the other at 1,800 gpm, supplying water to a constant-level tank located near the pump pit. The water flows from the constant-level tank through a 4-in. and a 10-in. pipe, both of which extend to the end of the laboratory. Weighing and volumetric tanks will be used for calibrating the measuring devices in the laboratory.

An extensive test program is being carried out at the Massachusetts Institute of Technology on the variation of the friction factor f with the Reynolds number for uniform flow in open channels. Three years' work has been completed and two years' additional testing is planned before the results will be fully analyzed prior to publication.

Flood waves and other waves of translation are under investigation at the National Hydraulic Laboratory of the U.S. Bureau of Standards. A paper, "Mathematical Theory of Irrotational Translation Waves," by Keuligan and Patterson, was published in the *Journal of Research* in January 1940, and other articles dealing with the effects of turbulence and channel conditions on the motion of translation waves are in preparation.

A broad program of density current investigations is also under way in cooperation with the National Laboratory. At the present time the main efforts are being concentrated on the flow of silt-laden currents of water into reservoirs. Through the cooperation of the government agencies involved, measurements are being taken on Lake Mead and Elephant Butte Reservoir. These measurements include temperature-depth, velocity, salinity, turbidity, conductivity, and elevation of the top of the silty layer. It is interesting to note that the location of the silty layer is found by sampling not only the water content, but also its temperature, for the temperature of the silty layer is found to be higher than that of the clear water immediately above it. This fact is also useful in determining the velocity of a silt-laden density current through a reservoir. In Elephant Butte Reservoir two thermometers have been placed, one at the outlet of the dam and the other at a known distance upstream. By noting the time that elapses between the temperature rise upstream and a similar rise downstream, the mean velocity of the silt layer passing downstream may be determined.

Experimental analyses made at the National Laboratory are concerned with the determination of the critical mixing velocity, or the velocity at which two bodies of liquid at different density in motion relative to each other would begin to mix through the action of breakdown of the waves formed at the interface. The criterion for this critical velocity, as developed from considerations of dimensional analysis, is

$$K = \frac{g\nu}{U^3} \cdot \frac{\Delta\rho}{e}$$

where K is a dimensionless coefficient, ν is the kinematic viscosity of the moving liquid, e is the density of the moving liquid, $\Delta\rho$ is the difference of the liquid densities, g is the acceleration of gravity, and U is the mean velocity of the moving liquid when mixing first occurs. An average value of $K^{1/3}$ appears to be about 0.155.

The Beach Erosion Board of the War Department has an interesting wave tank 85 by 14 ft in plan, with a vertical-plunger-type wave machine at one end and a sloping wave absorber at the opposite end. The experimental work now being conducted is primarily for checking the existing theory for use in evaluating wave actions in nature. To improve the experimental work, an oscillograph is being developed for simultaneously determining all wave characteristics, including profile and direction. In addition a long, narrow steel channel is being built with glass sidewalls placed at the far end for observing wave action on the "beach."

Channels with vegetal linings are a primary concern of the Outdoor Laboratory of the Soil Conservation Service at Spartanburg, S.C. Each channel is tested over a wide range of discharges and the values of Manning's and Kutter's roughness coefficients determined. The problem of erosion is likewise studied during these tests by determining the maximum allowable velocity before erosion develops in the underlying soil, which in these experiments is Cecil clay. One group of these tests indicates that a trapezoidal channel on a 30% slope lined with solid Bermuda sod, and with a bottom width of 1 ft and side slopes of 1:1, has a probable safe velocity of 8 ft per sec and a Kutter's *n* of 0.035.

Comparative tests are made between the types of grasses with the grass long, cut short, dormant, and at different periods of growth. It is interesting to note that the resistance or retarding effect of vegetation decreases with the depth of flow in a channel because of a "shingled" effect produced by the plants flattening against the channel bed in the direction of flow. If the stems of the vegetation are woody, this effect is not as pronounced, so the retarding effect does not decrease as rapidly with increase in depth of flow.

Technical Experts Appointed to Staffs of Zone Constructing Quartermasters

In an effort to decentralize the responsibility of carrying on the enormous defense construction program, the Construction Division of the Quartermaster Corps of the Army has divided the United States into nine Zones, each headed by a Zone Constructing Quartermaster. The nine Zones are coincident with the Corps areas of the Army command. The Zone Constructing Quartermasters report to Brig. Gen. Brehon B. Somervell, M. Am. Soc. C.E., who is Chief of the Construction Division. The Construction Quartermasters on the several projects in a Zone report to the Zone Quartermaster.

In February each Zone Constructing Quartermaster had assigned to his staff a Zone Engineer, a Zone Architect, and a Zone Operations Officer, chosen on the basis of their reputations as leading representatives of their respective professions. The Operations Officer is charged with supervising the execution of all construction work in the Zone. These assignments have been made by General Somervell.

The Zone Engineers, Architects, and Operations Officers were nominated for the consideration of General Somervell by the Construction Advisory Committee of the Army and Navy Munitions Board, which is composed of the following: John P. Hogan, Past-President Am. Soc. C.E., chairman; Ernest J. Russell, architectural member; E. P. Palmer, M. Am. Soc. C.E., contractor member; Malcolm Pirnie, M. Am. Soc. C.E., water supply member; and H. E. Foreman, Director of the Associated General Contractors of America. The newly appointed Zone officials follow:

Zone I—Army Base, Boston

Constructing Quartermaster, Major R. G. Richards, Q.M.C.
Zone Engineer—W. G. Grove, M. Am. Soc. C.E., Hartford
Zone Architect—Henry R. Shepley, Boston
Zone Operations Officer—Peter F. Connolloy, New York City

Zone II—120 Wall Street, New York

Constructing Quartermaster, Lt. Col. M A. McFadden, Q.M.C.
Zone Engineer—Enoch R. Needles, M. Am. Soc. C.E., New York City
Zone Architect—Robert B. O'Connor, New York City
Zone Operations Officer—H. M. Hale, M. Am. Soc. C.E., Long Island City

Zone III—Standard Oil Building, Baltimore

Constructing Quartermaster, Major J. H. Burgheim, Q.M.C.
Zone Engineer—Charles H. Stevens, M. Am. Soc. C.E., Philadelphia
Zone Architect—Louis M. Fisher, Baltimore
Zone Operations Officer—E. C. Macy, M. Am. Soc. C.E., Philadelphia

Zone IV—Marietta Building, Atlanta

Constructing Quartermaster, Colonel H. L. Green, U.S.A., Retired
Zone Engineer—Edward S. Bres, M. Am. Soc. C.E., New Orleans
Zone Architect—J. W. Humphrey, Atlanta
Zone Operations Officer—E. O. Korsmo, Memphis

Zone V—232 N. High Street, Columbus

Constructing Quartermaster, Major B. F. Vandervoort, Q.M.C.
Zone Engineer—Camden P. Fortney, Charleston, W.Va.
Zone Architect—Joseph L. Weinburg, Cleveland
Zone Operations Officer—Thomas Bentley, Toledo

Zone VI—Civic Opera Building, 20 N. Wacker Drive, Chicago

Constructing Quartermaster, Major E. C. Hayden, Q.M.C.
Zone Engineer—Robert Isham Randolph, M. Am. Soc. C.E., Chicago
Zone Architect—C. Herrick Hammond, Chicago
Zone Operations Officer—(To be appointed)

Zone VII—New Federal Building, Omaha

Constructing Quartermaster, Major M. E. Townes, Q.M.C.
Zone Engineer—Harry E. Frech, M. Am. Soc. C.E., St. Louis
Zone Architect—Eugene S. Klein, St. Louis
Zone Operations Officer—C. R. Conkey, Minneapolis

Zone VIII—Fort Sam Houston, San Antonio

Constructing Quartermaster, Lt. Col. E. V. Dunstan, Q.M.C.
Zone Engineer—Edward N. Noyes, M. Am. Soc. C.E., Corpus Christi
Zone Architect—Major Roy Leibsle, Q.R.C., San Antonio
Zone Operations Officer—F. G. Chamberlain, San Antonio

Zone IX—San Francisco

Constructing Quartermaster, Lt. Col. E. M. George, Q.M.C.
Zone Engineer—Harry W. Dennis, M. Am. Soc. C.E., Los Angeles
Zone Architect—Timothy L. Pflueger, San Francisco
Zone Operations Officer—E. T. Foley, Pasadena

Alfred Noble Prize Year Ends May 31

Award Made to Young Engineer for Paper of "Exceptional Merit"—Statement by Committee in Charge of Award

The Alfred Noble Prize, the highest honor open to younger members in the five national societies—American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the Western Society of Engineers—was established in 1929 in memory of the late Alfred Noble, a past-president of the American Society of Civil Engineers and of the Western Society of Engineers, and an outstanding American engineer. The award consists of a certificate, a cash prize which is dependent on income and is now $350, plus an allowance for the traveling expenses of the recipient to the annual meeting of the society of which he is a member and at which the award is made.

Normally the Alfred Noble Prize is awarded annually for "a technical paper of exceptional merit" which has been published during the year ending May 31 by one of the participating societies, provided that the author has not passed his thirty-first birthday at the time the paper is submitted for publication "in practically its final form."

The Prize Committee has always attempted to interpret the term "technical" in a liberal manner. The awards have gone both to papers of a largely descriptive type and to papers of a highly mathematical type. It is deemed essential, however, that any descriptive paper should be more than a mere general description. It should contain a sufficient amount of factual data, analysis, and detail to make it of more definite value to the profession than a simple "news report."

Similarly, the Prize Committee feels that no paper of the mathematical type is satisfactory if it offers no promise of practical application. Progress in engineering, it is held, is not measured by research or by theory but by practice. The award is for a technical rather than a scientific paper and practical values are a sine qua non.

Needless to say, the paper must be the individual work of the author—must reflect originality. Presumably any author will make suitable acknowledgment in his paper for aid or suggestions received from his colleagues or superiors, and all papers are naturally subject to the usual editorial changes of the publisher. A "joint paper," or one which does not reflect individual effort and initiative, is not, however, acceptable.

Similarly, a paper must be of "exceptional merit." The Committee recognizes that the junior group in our national societies—both the young engineers in practice and the young men undertaking postgraduate work in an engineering school—have made and are making valuable contributions to the technical progress of the engineering profession. It is natural, however, that many of these contributions will consist of minor improvements in the detail of existing practice or similar extensions of present theory or technique. The Committee is thus called upon to undertake to judge when such contributions are sufficiently outstanding to indicate "exceptional merit." This is of course a difficult question, and answering it, the Committee endeavors to secure the advice and counsel of senior engineers who are experienced in the special field covered by the paper in question.

It is also the view of the Committee that the paper should be of a character suitable for presentation at a meeting or for publication in the permanent technical records of the society concerned, that is, in its *Proceedings* or *Transactions*. If the Alfred Noble Prize is to be maintained on a high plane of competition, it is inevitable that the burden of proof as to importance and exceptional merit must rest with the paper. Accordingly the Committee, while attempting to keep its standards reasonable, must insist that "exceptional merit" be clearly demonstrated.

Papers are not "entered" for the Alfred Noble Prize. Each year a list of all papers that meet the "legal" requirements as to publication, authorship, and so forth, are studied by an appropriate group within each of the participating societies. The paper recommended by the representative of each society on the Alfred Noble Prize Committee is then considered by the Committee; of the papers so submitted one is selected by the Committee for the award, or no award is made.

Although awards have been made each year for many years past, the Alfred Noble Prize Committee has just announced, regretfully, that there will be no award of this outstanding prize for the twelve months ending May 31, 1940. It is the sincere hope of the Committee, however, that the current year will produce a paper which will receive unanimous approval for this notable award to younger members.

Engineering Foundation Supports Investigations

THE QUIET and efficient way in which the Engineering Foundation operates may sometimes tend to make us overlook the broad influence that it has on technical progress in many fields. In its annual report for 1939–1940 the Foundation describes two main projects in civil engineering and thirteen in other branches of engineering.

For the Society, one project is concerned with the Soil Mechanics and Foundations Division. The committee on Earth Dams and Embankments, headed by L. F. Harza, has three subcommittees, one dealing with Cores, Cutoffs, and Impermeazation, O. N. Floyd, chairman; one with Structural Design of Embankments and Foundations, T. A. Middlebrooks, chairman; and one on Consolidation of Embankment and Foundation Materials, William P. Creager, chairman. These committees have been particularly interested in gathering measurements of internal water pressure and settlement in earth dams.

The Committee on Sampling and Testing, under the chairmanship of Joel D. Justin and with M. Juul Hvorslev as research engineer, completed a report on undisturbed samples of soil. The work of developing better methods and equipment is being continued. Seepage and erosion have been the subject of an investigation by Glennon Gilboy's Committee on Seepage and Erosion. A report on filter experiments and on model earth dam studies made under L. G. Straub at the University of Minnesota is in preparation. Foundations have been studied by a committee under Lazarus White. A paper on "Lateral Earth and Concrete Pressures," by Lazarus White and George Paaswell, appeared in the 1939 TRANSACTIONS. Additional studies of building settlements and of the nature of quicksand, clay, and other soils are under way.

The second civil engineering project supported by the Engineering Foundation includes the work supervised by J. C. Stevens' Special Committee on Hydraulic Research of the Hydraulics Division. The elements of this project were outlined briefly on page 124 of CIVIL ENGINEERING for February and need only be tabulated here:

F. T. Mavis, "Conversion of Kinetic to Potential Energy in Expanding Conduits"

H. A. Thomas, "Traveling Waves on Steep Slopes"

M. P. O'Brien, "Phenomena of Intersecting Streams"

C. A. Mockmore, "Curves in Open Channels"

L. G. Straub, "Sedimentation at the Confluence of Rivers" and "Air Resistance to Flow of Water in Open Channels"

F. M. Dawson, "Simultaneous Flow of Liquids and Gases in Pipes"

Jacob E. Warnock, "Field Studies of Entrainment of Air on Spillways and in Chutes"

A number of the projects sponsored by the Engineering Foundation through the other Societies may also be of interest to civil engineers. Among these may be cited "Alloys of Iron Research" and "Internal Friction and Creep of Metals," under the American Institute of Mining Engineers; "Effect of Temperature on the Properties of Metals," "Fluid Meters," and "Rolling Steel" under the American Society of Mechanical Engineers; "Welding Research" under the American Institute of Electrical Engineers and the American Welding Society; studies on engineering education under the Engineers' Council for Professional Development; and "Plastic Flow of Concrete" under the University of California.

Defense News

From the Society's Representative in Washington, D.C.

MEMBERS of the Regular Army Reserve who are at present candidates for a degree at any college or university are to be deferred from active duty until the end of this academic year. If reservists apply for this deferment they will be ordered to active duty on July 1, 1941, instead of February 15, 1941, as now contemplated. Members of the Officers Reserve Corps and the enlisted reserve are included.

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Full arrangements have been completed for training 57,853 students in general engineering fields in connection with the national defense program. Utilizing the facilities of 119 engineering colleges, 775 courses are being started at once, to provide short intensive training courses for those who have necessary basic education and training for service as designers, inspectors, and production supervisors. These courses do not lead to any degree and are in no sense a substitute for regular engineering work. Some courses are open to high school graduates, others require 2 to 4 years of engineering education. The selection of students is by the engineering schools, and requests for information concerning enrolment should be sent to the school concerned. The entire cost of the instruction is borne by the Government from a $9,000,000 appropriation made by the last Congress.

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The Secretary of War has recalled to active service from retirement Brig. Gen. George R. Spalding, former Corps of Engineers officer. General Spalding has consented to serve as an additional member of the Construction Advisory Committee in the office of the Quartermaster General.

Also added to this important committee is Alonzo J. Hammond, Past-President of the Society, who has consented to assist the committee in its duty of passing on the qualifications of the contractors and the engineer-architects seeking participation in the defense construction program.

The addition of General Spalding and Dr. Hammond to this committee completes it to its full component of five members, as originally contemplated. The committee's function is to evaluate the experience of firms and recommend three of them for each construction project. Final selection is made by the Chief of the Construction Division, General Somervell. For the past eight months the committee has consisted of Forrest S. Harvey and Francis Blossom, both Members Am. Soc. C.E., and F. J. C. Dresser.

* * * *

The War Department has announced the award of contracts for the construction of military fortifications at six of the eight West Indies bases, the sites for which were received from Great Britain in exchange for 50 over-age destroyers. The estimated cost of the fortification work at the six bases—Bermuda, Newfoundland, British Guiana, Trinidad, St. Lucia, and Antigua—totals $102,000,000. The engineering-architectural contracts for the design work on these bases and the contracts for construction were awarded on a cost-plus-fixed-fee basis.

The Bureau of Yards and Docks of the Navy is negotiating contracts for the construction of the Navy facilities at several of these bases.

Simultaneous legislation is to be introduced into the current sessions of the Congress and the Canadian Parliament to authorize the start of the construction of a highway from the United States to Alaska. Three main routes are under consideration—two from Seattle via Hazelton, B.C., and one from Chicago across the Canadian Prairie provinces via the McKenzie River. The American Commission favors the route via Hazelton, to be of gravel construction, for military loads, and estimated to cost from $50,000,000 to $60,000,000. Three to fifteen years would be required for the completion of the road construction.

Society's Biographical and Professional Record File to Be Brought Up to Date

At a session held during the week of the Annual Meeting in January, the Board of Direction authorized a special appropriation in this year's budget which provides for bringing up to date the biographical and professional records of Society members. The existing records, which have proved of such value on so many previous occasions, were first compiled by a census started in 1921. In 1926, in 1931, and again in 1935 further request of the membership was made for additional data, and today the professional records of over 10,000 active members of the Society are available.

Increasing demands are being made at Society Headquarters for the current professional experience of Society members. Among those requesting such data from time to time are branches of the War Department, other federal government agencies, the public press, fellow members of the Society and others, usually with respect to prospective employment. In order that the Headquarters office may promptly and efficiently furnish such data, current information is essential. The Society endeavors to perform a public service in furnishing biographical material concerning its members, and directly or indirectly the member himself receives recognition. During the present emergency, civil engineers of all specialties are in demand in the various industries engaged in the national defense program.

To encourage a greater return and to save members time and unnecessary duplication in listing information already available at Society Headquarters, the biographical and professional record form will indicate the last date on which information was supplied. The member will be requested to furnish only information in addition thereto. The Headquarters staff is now engaged in checking the dates on which the professional records were last submitted.

Shortly blanks will be forwarded to each member, whereon he may bring his professional record up to date. It is hoped that each record will give a clear picture of engagements and responsibilities and will be returned promptly to Society Headquarters.

Fort McHenry, Birthplace of "The Star Spangled Banner," and Baltimore, Md., Site of the Spring Meeting
See Page 177 for Condensed Program

Equipment Completed for Air Entrainment Studies

In accordance with the terms of the J. Waldo Smith Fellowship Award, experiments are being undertaken at the Iowa Institute of Hydraulic Research, University of Iowa, on the entrainment of air in pipe flow. J. M. Robertson, who received the award, reports that apparatus has been constructed using a 6-in. pipe of transparent plastic 40 ft long. It is supported on a steel I-beam which can be placed at various slopes up to about 1 to 4. The pipe is provided with a gate upstream for varying the depths of flow, and just below the gate there is a T-connection to be used in supplying air as needed. At the downstream end the pipe is joined to a rectangular box from which the water discharge is controlled with a sliding gate and the air discharge with a small needle valve. The rate of water discharge is to be measured by plate orifices in the supply line. Two such orifices have been calibrated for measurement of flow rates between 0.05 and 1.80 cu ft per sec.

The program of investigation is now being started and is divided into three stages. In the first it is planned to have the experimental section consist of a straight portion of pipe which will be placed at various slopes between horizontal and the maximum slope. For the second stage the experimental section will be a short horizontal piece followed by a reach of pipe that can be set at any slope up to the maximum. In the final stage the water is to enter the experimental section through a vertical pipe (in which the flow is upward), through a horizontal portion, and then into an inclined section. This last stage is to represent the conditions found in pipe lines in which the water flows over a high point.

Committee on Juniors Recommends Action

In the 1940 annual report of the Society's Committee on Juniors, it is brought out that discussions held during the meeting at Cincinnati dealt with the two topics always uppermost in the minds of the Juniors—their professional development and their economic welfare. The recommendations of the Committee on the first item are that members of the Society help to make available, to Juniors who wish it, instruction in advanced courses in engineering, preferably in connection with established engineering schools; but when these are not available, that members enlist the services of engineers in the locality who are capable of leading study groups.

Second, the Committee recommended that individual members and Local Sections help in the formation and operation of Junior forums where the Juniors themselves want such special organizations. If the number of Juniors is small, the Committee suggests that they participate in Section affairs not only by having a Junior on each committee, but preferably by having Juniors accept a definite job for which they can take the entire responsibility.

In considering the economic welfare of the Junior, the Committee decided that the responsibility for insuring that the salary and title of young engineers keep pace with the work they are doing, rests squarely upon the engineer-employer. This is particularly true because more than 90% of the young engineers work for older engineers and cannot advance without the cooperation of their seniors. The Committee hopes that employer-engineers will feel a personal obligation to the profession to advance men under them as fast as opportunity and ability permit.

Copies of the Committee's full report have been sent to the secretaries of all the Local Sections and to the various Junior groups.

Motion Pictures of Tacoma Bridge Collapse Available

So much interest has been shown in the motion pictures of the Tacoma Bridge failure that the Society has purchased two films for use at Local Section and Student Chapter meetings. These are 16-mm silent films, in color, and were secured through the courtesy and interest of F. B. Farquharson, Assoc. M. Am. Soc. C.E., Associate Professor of Civil Engineering, University of Washington, Seattle, Wash. Requests for the use of these films should be addressed to Society Headquarters and will be filled, so far as practicable, in the order of receipt.

Federal Funds for Military and State Highways

RECOMMENDATIONS for legislation and for Congressional appropriations in the amount of $287,000,000 for immediate defense highway construction, and for the planning of roads to be built later, have been submitted to the President by the Public Roads Administration. Congress will be asked for $150,000,000 for immediate construction of access roads to serve military and naval reservations and defense industries. Another $100,000,000 will be sought for immediate use in strengthening weak sections of the national highway system that have been designated by the War and Navy Department as the "strategic network." For the construction and repair of special tactical roads designated by the War Department, $25,000,000 is asked, and $12,000,000 will be needed for the present planning of road improvements to be built after the present emergency is over.

The report recommends that the construction of the access roads be carried out by the Public Roads Administration entirely at Government expense, but in cooperation with the state highway departments. On the other hand, the strengthening of the strategic highway net will require state aid funds, but the federal contributions will be greater than the usual fifty-fifty arrangement in effect on the federal-aid highway program. War Department tactical roads will be constructed entirely with federal funds but under the supervision of the Public Roads Administration. Whenever state or county expenditures are made for repairing roads damaged by military use, the report to the President recommends that provision be made by Congress for reimbursement in full.

REGULAR FEDERAL-AID HIGHWAYS

For the fiscal year 1942, the regular federal-aid appropriation for primary roads is scheduled to total $100,000,000, divided among the states according to need. The individual state appropriations, announced by the Public Roads Administration, vary from $487,500 each for the states of Delaware and Rhode Island, to $6,294,440 for the State of Texas. In addition, $17,500,000 is anticipated for secondary and feeder roads and $20,000,000 for grade-crossing separations.

To Stimulate State Systems of Plane Coordinates

MATERIAL progress in the methods and practice of large-scale and local surveying is being effected continuously. One method that has gained a great deal of favor is the use of plane coordinates; this is being developed in various parts of the country on the basis of state units. A number of articles in CIVIL ENGINEERING have detailed the advantages of the system and have described its practical working.

A further endorsement, throwing the weight of the Society as a whole behind this movement, is now given through the adoption of the following resolution by the Board of Direction at its January 13 meeting:

"WHEREAS, fixed markers upon which land surveys are based are constantly subject to physical eradication or dislocation; and

"WHEREAS, to the end that boundary disputes may be minimized, it is highly desirable that the position of such markers be permanently recorded in such a way that the markers are susceptible of accurate replacement or relocation when the need therefor arises; and

"WHEREAS, the State Systems of Plane Coordinates, now in use in several of the States and approved by the American Bar Association and the American Society of Civil Engineers, offer an accurate and practicable method of accomplishing the desired purpose;

"*Now, therefore, be it resolved:* That the American Society of Civil Engineers favors the establishment of the State Systems of Plane Coordinates by the State Legislatures."

Such systems have long been advocated by the Society's Surveying and Mapping Division. In addition, the American Bar Association, which has had representation with the Division on a joint committee studying such matters, has adopted a similar resolution. The present action of the Board of Direction is expected to further strengthen the chance of adoption of the plane coordinate system by other states.

Nebraska Section Aids Its Students and Juniors

By ROY M. GREEN, M. AM. SOC. C.E.

PRESIDENT, NEBRASKA SECTION

In the following brief article Mr. Green explains the novel plan, initiated by the Nebraska Section, of furnishing each Junior with a personal adviser.

IN THE area comprising the Nebraska Section of the Society, a complete program of professional activities recommended by the Engineers' Council for Professional Development has been initiated. About two years ago a program of vocational guidance, one of the recommendations of E.C.P.D., was started by a committee of the Nebraska Engineering Society. The activities of this committee the first year included a careful study of similar work in various parts of the United States. The chairman of the committee outlined a complete plan for starting vocational guidance in all the high schools in the city of Omaha. This program has been put into operation since that time, and a similar one was started in Lincoln this year. It is hoped that the program can be expanded to include all the principal high schools in the state.

A little over a year ago the Nebraska Section of the Society undertook a plan, which apparently has not been tried in other Sections, to assist in the professional development of young men who have already entered the civil engineering field. It was thought that the corporate members could be of maximum assistance to the younger men if a friendly and fairly close connection could be made with them while they are still students. The procedure adopted called for cooperation between the Section's Committee on Student Chapters and the Committee on Juniors, and a circular letter was sent to all the corporate members of the Section outlining the proposed activity.

The plan provided that, beginning January 1, 1941, there would be made available to the seniors in the University of Nebraska Student Chapter the names of approximately twenty corporate members of the Section. Each senior in the Chapter was to be permitted to select one person from this list to be his personal adviser. It is the duty of this corporate member to make himself known to the senior, so that the two can get personally acquainted. This acquaintanceship should be close enough so that the senior will feel at liberty to visit the corporate member whenever he wishes. It is expected that the member will permit the senior to observe his work whenever feasible. It is intended that this contact shall extend over a period of at least five years.

After graduation and when the student becomes a Junior in the Society, he will be given annually a very comprehensive personal-appraisal questionnaire, which covers an analysis of his response to his occupation, professional status, and the general program of development. The questionnaire is to be furnished each year to all Juniors in the Section. The Junior will be urged to use the questionnaire for the purpose of making a careful and critical analysis of himself and his position. If after making this analysis he decides that he is weak in any particular regard, he will be invited to get in touch with the chairman of the Junior Committee, so that he may be advised concerning a program of self-development.

The response to the circular letter sent out explaining the program has been generous. Seventeen corporate members expressed their willingness to give the unlimited amount of time required in assisting the young men to get a good start. The names of this group of seventeen were then submitted to the Student Chapter, and each of the twelve seniors selected one as his personal adviser.

This activity was begun so recently that there is no way of knowing yet how it will develop. However, it is clear that the students are very anxious to have it succeed, and it is believed that many more corporate members will be willing to participate the next time names are submitted.

This plan seems to constitute the best method for bringing the members of the Section into contact with their Juniors, since the Section has no concentration of Juniors in any one city.

Later an attempt will be made to encourage intelligent self criticism on the part of the young men. For this purpose the Section proposes to use the E.C.P.D. Personal Appraisal Questionnaire which has been revised to cover use by civil engineering students and the conditions obtaining in the state of Nebraska. It may be three or four years before the Section can know whether this activity is to achieve any real result. It is believed, however, that it will be of increasing helpfulness to all concerned.

By-Laws, Article IV, Changed to Add Committee on Society Relationships

Following due notice, as given at the October 15, 1940, meeting of the Board of Direction, the Society By-Laws were changed, at the January 1941 meeting, by adding a Committee on Society Relationships. The necessary revisions apply to Article IV, "Committees." In Section 1, at the end of the list of standing committees, the following is added:

"A Committee on Society Relationships."

The nature and duties of the new committee are detailed in a new Section 9, as follows:

"9. The Committee on Society Relationships shall consist of three Directors. This Committee shall act as a liaison group between the Board of Direction and the Society's representatives on the Boards of United Engineering Trustees, Inc., Engineering Societies Library, and Engineering Foundation, and such other organizations as the Board may direct, to the end that the Board of Direction may be currently informed of the problems and actions of these several administrative or other bodies."

The succeeding sections are renumbered, beginning with Section 10, to accommodate the insertion of the new Section 9.

Promotion of Registration of Engineers

A number of duties devolve upon the Society's Committee on Registration of Engineers. It has the oversight of the Model Law as sponsored by the Society, of relations with other bodies, such as the National Council of State Boards of Engineering Examiners, and of such activities as have to do with the maintenance or extension of the policy of registration.

Based on the report of this committee, following its studies during the year 1940, the Board of Direction at its January meeting adopted the following committee recommendations:

"1. That the 1941 Committee meeting be held in New York City just before or after the Annual Meeting of the National Council of State Boards of Engineering Examiners, and that the Committee on Registration of the American Society of Mechanical Engineers be invited to meet with the Committee.

"2. That Local Sections be urged to cooperate with all organized state groups that are working for the advancement of the engineer.

"3. That Local Sections be asked to help find additional funds for their state boards, if the appropriations are insufficient for proper operation, including support of the National Council and reimbursement for the expenses of a delegate to its Annual Meeting.

"4. That Local Sections be asked to make special efforts to secure the revision of those laws whose requirements for registration are definitely low."

News of Local Sections

Scheduled Meetings

Cleveland Section Luncheon meeting at the Guildhall on March 3, at 12:15 p.m.

Dayton Section—Luncheon meeting at the Dayton Engineers' Club on March 17, at 12:15 p.m.

Florida Section—Meeting at Tallahassee on March 24, at 12 m.

Illinois Section—Dinner meetings of the Junior Section at the Central Y.M.C.A. Cafeteria on March 10 and 31, at 6 p.m. (Meeting at 7 p.m.) Public speaking class for Juniors every Monday evening from February 10 to March 24.

Indiana Section—Meeting in Hurty Hall, Indiana State Board of Health, on March 12, at 7:15 p.m.; dinner at Riley Hospital, at 6:15 p.m.

Los Angeles Section—Dinner meeting at the University Club on March 12, at 6:15 p.m.

Metropolitan Section—Technical meeting in the Engineering Societies Building on March 19, at 8 p.m.

Miami Section—Dinner meeting at the Alcazar Hotel on March 6, at 7 p.m.

Michigan Section—Joint dinner meeting with the Oakland County Engineering Society at the Birmingham (Mich.) Community House on March 11, at 6:30 p.m.

Mohawk-Hudson Section—Meeting at the Albany Institute of History and Art on March 6, at 8 p.m.

Northwestern Section—Joint dinner meeting with the A.S.M.E. and A.I.E.E. at the Minnesota Union on March 3, at 6:15 p.m.; dinner meeting of the Junior Chapter at the Minnesota Union on March 4, at 6:30 p.m.

Philadelphia Section—Joint dinner meeting with the Engineers Club of Trenton at the Engineers' Club on March 11, at 6 p.m.

St. Louis Section—Luncheon meeting at the York Hotel on March 24, at 12:15 p.m.; joint meeting with St. Louis Engineers, Club at the Engineers' Club on March 6, at 8:15 p.m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.

San Francisco Section—Dinner meeting of the Junior Forum at the Engineers' Club on March 18, at 5:30 p.m.

Seattle Section—Joint dinner meeting with the Founder Societies at the Arctic Club—date to be set by the A.I.E.E.

Spokane Section—Luncheon meeting at the Davenport Hotel on March 13, at 12 m.

Syracuse Section—Dinner meeting at the Onondaga Hotel on March 3, at 6:30 p.m.

Tacoma Section—Dinner meeting at the Lakewood Community Center on March 11, at 6:30 p.m.

Tennessee Valley Section—Dinner meeting of the Knoxville Sub-Section at the S and W Cafeteria on March 11, at 5:45 p.m.

Texas Section—Luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on March 10, at 12:15 p.m.; luncheon meeting of the Dallas Branch at the Dallas Athletic Club on March 3, at 12:10 p.m.

Tri-City Section—Dinner meeting at Davenport, Iowa, on March 14, at 6:30 p.m.

Recent Activities

Central Ohio Section—*Columbus, January 16:* A talk on "Recent Developments in Portland Cement with Particular Reference to Treated Cements" comprised the technical program. This was given by E. C. Wenger, regional highway engineer for the Portland Cement Association.

Cincinnati Section—*January 16:* Joint meeting with the Cincinnati Engineers' Club. The main speaker was Nelson Glueck, professor of Bible and Biblical archaeology at Hebrew Union College, who gave an illustrated lecture entitled "An Archaeologist Looks at Palestine."

Cleveland Section—*January 6:* During the annual business meeting the following officers were elected for 1941: George W. Hamlin, president; George E. Barnes, vice-president; and G. Brooks Earnest, secretary-treasurer. Col. U. S. Grant, 3d, division engineer for the Corps of Engineers at Chicago, then spoke on "The Present Military Preparedness Program." James H. Herron, retiring president of the Section, concluded the meeting by installing the new officers.

Colorado Section—*Denver, January 13:* Following a business meeting Walker R. Young, assistant chief engineer of the U.S. Bureau of Reclamation, was introduced and gave an illustrated lecture on different aspects of the Central Valley Project. Until his recent transfer to Denver, Mr. Young was supervising engineer for the Bureau on the project.

Dayton Section—*January 20:* An account of the flood-control work being done by the government throughout the country was presented by William F. Simpson, engineer for the U.S. Department of Agriculture in charge of flood control surveys for the Ohio Valley Region.

DISTRICT OF COLUMBIA SECTION—*Washington, January 24:* Guests at the annual dinner meeting included President Fowler, Vice-President Stevens, Secretary Seabury, and Field Secretary Jessup. A paper on "Australia's Place in the World," prepared for the occasion by the Hon. Richard G. Casey, Australia's Minister to the United States, was read in Mr. Casey's absence by Alan G. Gutteridge. Then L. F. Livingston, manager of the Agricultural Extension Division of the Du Pont Company, discussed the value of research and what the chemical industry is doing in connection with the present emergency. A short talk by President Fowler concluded the evening.

DULUTH SECTION—*January 20:* During the business meeting the following officers were elected for 1941: Roland C. Buck, president; C. K. Clickener, first vice-president; E. George Fulton, second vice-president; William E. Hawley, secretary; and John Carson, treasurer. The technical program consisted of a talk by Warren Moore on "New Uses for Softwoods," in which he discussed studies being made to find new industries for northern Minnesota.

FLORIDA SECTION—*December 28 and January 23:* At the first of these sessions certificates of life membership in the Society were presented to two members. The annual election of officers resulted in the selection of Charles F. Lovan for president, and J. A. Riviere for secretary-treasurer. The speakers at the January meeting were O. L. Adams, associate engineer in the U.S. Engineer Office at Mobile, Ala., who discussed the defense construction projects under the supervision of his office, and Capt. C. W. Hamilton, who described the Tallahassee Airport Project.

GEORGIA SECTION—*Atlanta, January 13:* Following a dinner and business meeting engraved gavels were presented to several of the former presidents of the Section. The technical program consisted of the showing of the Tacoma Narrows Bridge film and a discussion of the failure of the structure by C. N. Crocker, chief bridge engineer for the Georgia State Highway Department.

ILLINOIS SECTION—*Chicago, January 9, 10, and 24:* The first of these meetings was a joint session with the Chicago Engineers' Club for the purpose of seeing the Tacoma Bridge films. On the 10th the Section joined with several engineering groups in sponsoring a dinner meeting, at which a symposium on "What Price Defense?" was featured. At the meeting held on the 24th the following officers were elected for 1941: R. I. Randolph, president; F. T. Darrow and H. P. Ramey, vice-presidents; and John F. Seifried, treasurer.

INDIANA SECTION—*Indianapolis, January 10:* The showing of three films—on the Tacoma Bridge, the "Conquest of the Hudson" (compiled by the Port of New York Authority), and the care of small water supply systems—comprised the technical program. During the business meeting the following new officers were elected: L. E. Martin, president; Ben H. Petty, vice-president; and Denzil Doggett, secretary-treasurer. J. I. Perrey was reappointed assistant secretary.

IOWA SECTION—*Ames, January 15:* Joint meeting with the Iowa State College Student Chapter. A general discussion of suspension bridge principles, conducted by Prof. Frank Kerekes, initiated the technical program. Next there were practical demonstrations by means of a 20-ft model of a suspension structure. This program led up to the showing of motion pictures of the Tacoma Narrows Bridge.

ITHACA SECTION—*January 13 and 22:* On the 13th a dinner in honor of Glenn B. Woodruff preceded a joint meeting with the Cornell University Student Chapter. Mr. Woodruff, who was engineer of design on the San Francisco-Oakland Bay Bridge, discussed the design of the structure. At the second of these meetings Henry N. Ogden, emeritus professor of sanitary engineering at Cornell University, spoke on the New York State Health Department.

KANSAS SECTION—*Topeka, January 17:* Following a business session M. W. Watson, general contractor of Topeka, discussed his experiences in building the Fort Riley Cantonment.

LOS ANGELES SECTION—*January 8:* A general symposium on the proposed Engineering Professions Act was presented in three short talks: "A Record of Similar Acts in Other States," by Donald M. Baker; "A Summary of the Proposed California Act," by A. M. Rawn; and "Possible Effects of the Proposed Act on the Aims and Activities of the Society," by Raymond A. Hill. The rest of the program consisted of an illustrated lecture on the Tacoma Bridge disaster, given by Nathan A. Bowers, Pacific Coast editor of the *Engineering News-Record.*

MARYLAND SECTION—*Baltimore, January 9:* The principal speaker was J. B. Ferguson, engineer and constructor of Hagerstown, Md., who reminisced concerning his early work for the Burlington Railroad in the extension of its lines west of the Mississippi and Missouri rivers. The talk was illustrated with slides made especially for the meeting from photographs he had taken forty years ago.

METROPOLITAN SECTION—*January 8:* An illustrated talk on "Military Aircraft and Performance" was given by Maj. Alexander P. de Seversky, specialist reserve for the U.S. Air Corps. The paper was discussed by Alexander Klemin, director of the Guggenheim School of Aeronautics at New York University.

MICHIGAN SECTION—*Ann Arbor, January 24:* Joint meeting with the University of Michigan Student Chapter. Following a short talk on the failure of the Tacoma Bridge, the speaker of the evening, Vice-President Charles B. Burdick, was introduced. Mr. Burdick, who is a life member of the Society, discussed the reasons why he had found it profitable to pay dues to the Society for thirty-five years.

MID-MISSOURI SECTION—*Jefferson City, December 13:* The technical program consisted of a talk by Lt. Col. L. C. Gordon, professor of military science at the Missouri School of Mines. Colonel Gordon's subject was the establishment of the Seventh Corps Area Training Camp in the Mark Twain Forest Unit, near Rolla. An informal discussion of the engineering implications of the project concluded the meeting.

MOHAWK-HUDSON SECTION—*Troy, N.Y., January 7:* A talk on "The Engineer as a Public Speaker" was the feature of the occasion. This was given by Homer H. Nugent, head of the department of English at Rensselaer Polytechnic Institute.

NASHVILLE SECTION—*February 4:* Following the routine business of the Section and the showing of the Tacoma Bridge film, a lecture and demonstration on the use of the polariscope in stress analysis of structures and structural members was presented by F. L. Castleman, Jr., associate professor of structural engineering at Vanderbilt University.

NEBRASKA SECTION—*January 27:* Joint meeting with the Lincoln Engineers' Club, the Student Chapter at the University of Nebraska, and the student section of the American Society of Agricultural Engineers. The Tacoma Bridge film was shown before dinner. The evening program consisted of an illustrated lecture on "General Motors 2-Cycle Diesel Engine," by A. C. Boock, chief engineer of the Springfield works of the Allis-Chalmers Manufacturing Company.

NEW MEXICO SECTION—*Albuquerque, January 22:* The meeting took place in the testing laboratory at the University of New Mexico, where demonstrations showing the proper procedure in concrete mix design were given. Prof. W. C. Wagner, of the civil engineering department, presented a paper on "Concrete Mix Design and Control."

NORTH CAROLINA—*Raleigh, January 25:* Talks were given by W. B. Truitt, whose subject was "The Science of Modern Welding"; Harold C. Bird, professor of civil engineering at Duke University, who discussed navigation; and E. W. Berry, associate professor of geology at Duke, who gave an illustrated lecture on "Peculiar Late Formations in Eastern North Carolina." The presentation of committee reports concluded the meeting.

NORTHEASTERN SECTION—*Boston, January 20:* During the annual business meeting the following officers were elected for 1941: Carroll A. Farwell, president; Harry P. Burden, vice-president; and Emil A. Gramstorff, secretary-treasurer. The guests of honor and speakers were President Fowler and Secretary Seabury. The latter discussed the diverse activities of the secretarial and field force of the Society in furthering its aims and objectives, while Mr. Fowler concluded the meeting with a brief talk on the various activities of the Society.

NORTHWESTERN SECTION—*Minneapolis, February 3:* A lecture on the Lake Traverse-Bois de Sioux conservation project in western Minnesota comprised the technical program. This was given by Maj. John W. Moreland, district engineer for the U.S. Engineer Office at St. Paul.

OREGON SECTION—*January 6:* "Our Relations with the Latin-American Republics" was the subject of a talk by Earl Nixon, director of the department of geology and mineral resources for the State of Oregon. The new officers for the Section elected at this time are C. E. Green, president; C. I. Grimm, first vice-president; G. W. Holcomb, second vice-president; F. M. Warren, Jr., secretary; and R. E. Cushman, treasurer.

PANAMA SECTION—*Panama City, December 2:* At the annual dinner meeting the following officers were elected for 1941: T. B. Larkin, president; F. W. Edwards, first vice-president; C. S. Pineo, second vice-president; and J. T. Tucker, secretary-treasurer. Clinton Morse, retiring secretary, gave a brief résumé of his trip to the Cincinnati Meeting.

PHILADELPHIA SECTION—*January 14:* This meeting was devoted to the subject of airports. First, the general aspects of airport construction were discussed by Albert H. Wessel, district airport engineer for the Civil Aeronautics Administration. The new Philadelphia Municipal Airport was then considered in some detail, the speakers being John H. Neeson, director of the Philadelphia Department of Public Works; John E. Allen and Edwin R. Schofield, respectively principal assistant engineer and division engineer of design for the Philadelphia Bureau of Engineering, Surveys, and Zoning; Paul J. Essick, Jr., deputy chief of the Bureau of Highways of Philadelphia; and Samuel S. Baxter, assistant director of the Department of Public Works.

PITTSBURGH SECTION—*January 8 and 16:* The first of these occasions was a testimonial dinner to Rudolf P. Forsberg, former chief engineer of the Pittsburgh and Lake Erie Railroad. Those paying tribute to him were Parke H. Martin, W. J. Montgomery, and the Rev. W. W. Corcoran. Mr. Forsberg replied briefly, and Director C. G. Dunnells also spoke. Certificates of life membership were presented to six members of the Section. The second session was a joint meeting with the civil section of the Engineers' Society of Western Pennsylvania. The speaker of the evening was Don R. Berlin, chief engineer of the Curtiss Airplane Division of the Curtiss-Wright Corporation, who discussed problems confronting the airplane designer.

SACRAMENTO SECTION: The speakers at the regular luncheon meetings held in January were Daniel Cate, president of the Section; J. S. Bamesberger and D. C. Johnson, of the U.S. Soil Conservation Service; and J. R. Dieffenbacher. On the 14th the following new officers were elected: Martin H. Blote, president; Asa G. Proctor, vice-president; and Emerson Dolliver, secretary. The annual dinner dance was held on the 17th.

ST. LOUIS SECTION—*January 27:* An illustrated lecture on "The St. Louis River Front Before the Bridge" was the feature of the occasion. This was given by Charles E. Peterson, senior landscape architect for the National Park Service.

SAN FRANCISCO SECTION—*Junior Forum, January 28:* The speakers were Jack Kimball, of the Palo Alto Water Department, whose subject was "Cannery Waste Studies for Palo Alto," and Harvey Ludwig, of the East Bay Cities Sewage Survey, who discussed the work of that survey. Then Alfred Finnila and Blair Burnson led a general discussion on the subject, "Should the Civil Engineer Have a More Liberal Education?"

SOUTH CAROLINA SECTION—*Columbia, January 10:* Joint meeting with the South Carolina Society of Engineers. There was an all-day session and one in the evening, the speakers being Prof. Stephen Taber, of the University of South Carolina; S. B. Earle, director of the School of Engineering at Clemson College; J. S. Williamson, chief highway commissioner of South Carolina; T. Keith Legaré, secretary of the State Board of Engineering Examiners; J. E. Gibson, engineer and manager of the Charleston Water Works; Prof. A. B. Credle, of Clemson College; and Dr. William P. Jacobs, president of Presbyterian College at Clinton, S.C. During the business meeting James E. Gibson was elected president, and J. G. Wardlaw, vice-president. Albert E. Johnson was reelected secretary-treasurer.

SYRACUSE SECTION—*January 20:* The Section held a dinner preceding a joint session with the Technology Club of Syracuse. The speaker and guest of honor was John C. Page, U.S. Commissioner of Reclamation, who gave an illustrated lecture on the Central Valley Project in California. During the dinner certificates of life membership were presented to four.

TACOMA SECTION—*January 11:* Following a steak dinner and musical program, certificates of life membership were presented to two members of the Section. Farlin B. Nye led the group in spirited singing, and dancing and cards concluded the evening.

TENNESSEE VALLEY SECTION—*Chattanooga Sub-Section, January 14:* The feature of the occasion was a talk on "The History of the Chattanooga Water Works and the Operation of the System." This was given by A. F. Porzelius, manager of the City Water Company. *Knoxville Sub-Section, January 21:* Prof. E. S. Fabian, chairman of the program committee, entertained the group with his cartoons on engineering subjects. Later the motion picture of the collapse of the Tacoma Bridge was shown, with introductory remarks by A. T. Granger, associate professor of civil engineering at the University of Tennessee.

TRI-CITY SECTION—*Clinton, Iowa, January 15:* On this occasion members of the Section were guests of the Clinton Engineers Club. In the afternoon the group made an inspection trip to the plant of the Clinton Company, where plant chemists described the various steps in the conversion of corn to sugar and syrup. Following a dinner in the evening, G. L. Cox, of the International Nickel Company, spoke on "The Corrosion Resistance of Nickel and Its Alloys."

WYOMING SECTION—*Cheyenne, January 24:* The principal speaker was R. J. Tipton, consulting engineer of Denver, who discussed the international water situation in regard to the Rio Grande and Colorado rivers. During the business meeting it was announced that the following officers will serve during the coming year: A. J. McGaw, president; Ned Williams, vice-president; J. Roland Carr, secretary-treasurer; De Mar McKinnon, assistant to the president; and Ray A. Campbell, assistant to the secretary.

Student Chapter Notes

BROWN UNIVERSITY—*January 21:* Joint session with the Rhode Island State College Student Chapter. The speakers and guests of honor were President Fowler and Secretary Seabury. The former discussed the differences between the East and the West in engineering training and opportunity, while Mr. Seabury spoke on the organization of the Society. In the evening the Chapter members attended a dinner of the Providence Section, given in honor of Messrs. Fowler and Seabury.

CORNELL UNIVERSITY: The Chapter reports that a number of interesting meetings have been held in the past few months. The list of speakers addressing these sessions included S. C. Hollister, dean of the Cornell College of Engineering; Maj. J. C. Marshall, district engineer for the Binghamton (N.Y.) office of the U.S. Engineer Department; and Glenn B. Woodruff, consulting engineer of San Francisco. On one occasion a motion picture entitled "The New Story of Ancient Wrought Iron" was shown through the courtesy of the A. M. Byers Company.

MANHATTAN COLLEGE—*February 2:* An illustrated lecture on concrete piles was given by Charles Gilman, vice-president and general manager of the Massey Concrete Products Corporation, New York.

MICHIGAN STATE COLLEGE—*January 28:* Members of the Chapter were in charge of the meeting, and one of them presented the Society's illustrated lecture on Boulder Dam.

NEWARK COLLEGE OF ENGINEERING—*December 2:* The construction features of the Edison Memorial Bridge were discussed by Morris Goodkind, New Jersey state bridge engineer, who illustrated his talk with lantern slides and motion pictures.

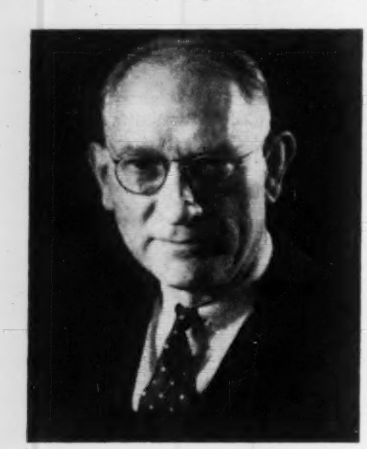
STATE UNIVERSITY OF IOWA: Speakers at recent meetings of the Chapter include Howard A. Hook, chief of the Project and Survey Section of the Civil Aeronautics Authority, who discussed "Airports and Airport Construction," and Lee Fah Yih, an alumnus of the university, who spoke on "Road Construction in China." Various members of the faculty have also appeared on the programs.

ITEMS OF INTEREST

About Engineers and Engineering

W. W. De Berard Becomes Chicago City Engineer

WELL known to Society members for his generous and active contributions to the work of committees and local groups as well as his participation in technical affairs, W. W. De Berard resigned on February 3 from his position as Western Editor of *Engineering News-Record* to become city engineer of Chicago. Mr. De Berard, who served as Director of the Society from 1938 to 1941, graduated from M.I.T. in 1901. During the succeeding nine years he engaged in various phases of sanitary work in cities as widely scattered as Denver, Oakland (Calif.), Philadelphia, and New York. He joined the Chicago staff of *Engineering Record* in April 1910 and retained his editorial connection with that magazine and its successor, the *Engineering News-Record*, until the present. Recently he was retained by the Sanitary District of Chicago as a member of the board of review concerned with the problem of lake levels.



W. W. DE BERARD

Ralph Budd Receives New Distinction

FOR HIS outstanding service in engineering, particularly his contributions to the various phases of railway development including the streamlined train, Ralph Budd on January 15 received the John Fritz Medal awarded by action of a board representing the Founder Societies. Now, on February 3, Frank F. Fowler, chairman of the Washington Award Commission, announces that Ralph Budd is to be honored by the Award for 1941. The citation is for "vision and courageous leadership in advancing the technological frontiers of high-speed railroad transportation." Herbert Hoover was the first to receive the award in 1919; Mr. Budd is the eighteenth recipient.

CIVIL ENGINEERING for April

ORGANIZATION and operation of the new Army Engineer aviation regiment will be the subject of a paper written by Capt. Carroll T. Newton. The regiment is equipped primarily for the rapid construction of airport runways and airport structures, and works in close cooperation with the air corps. As in other defense problems, speed is the important consideration.

Postponed from the present issue in a last-minute emergency, Mr. Feld's paper on applications of soil mechanics to heavy construction practice is expected to appear in April. The material in this article is especially valuable as an index of the best thought on such subjects as the use of soldier beams and the "holding-down power" of piles.

Methods of alinement for obtaining accuracies as great as 0.05 mm in a structure 1,300 ft long are discussed by Carl I. Aslakson in connection with the construction of the David W. Taylor Model Basin at Carderock, Md. Sag wire procedures are compared with an optical method utilizing special lifts and a first-order theodolite with a 50-power telescope.

Other subjects that are tentatively scheduled for April include a description of engineering conditions in Hawaii, data on the design of notched effluent troughs for settling basins, and a study of split-ring connectors for lumber and plywood joints.

Page of Special Interest

DURING December 1940, Miss Lili Réthi, whose drawing of the Engineering Societies Building in New York appeared on the cover of CIVIL ENGINEERING for September 1939, exhibited her work at the Architectural League of New York. Included in this exhibition, in addition to recent construction and architectural subjects done in this country, were several pencil drawings made in England and on the Continent. One of the latter is shown on the Page of Special Interest in the front of this issue. This was originally a poster —a striking drawing of the Little Belt Bridge between Jutland and the Island of Fyen, Denmark. The poster was used at the opening of the bridge in 1935.

Although the Architectural League exhibition was the first public showing of Miss Réthi's work in this country, her compositions had previously been brought to the attention of British and European engineers at gatherings on the Continent—at the Verein Deutscher headquarters in Berlin in 1931, at the World Power Conference in Stockholm in 1933, and at the Technical Museum at Vienna in 1934.

Miss Réthi is becoming known in this country also through drawings that have appeared in CIVIL ENGINEERING, *Mechanical Engineering*, and on the covers of several McGraw-Hill publications. In handling subjects of engineering and architectural interest, she gives a very energetic and appealing quality to the sometimes grotesque outlines of excavations and structures on which work is in progress. The full-page reproduction in the front of this issue well illustrates Miss Réthi's ability to dramatize the work of the civil engineer.

Prof. N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

"GENTLEMEN of the Club, you will recall that Professor Wise, our guest at the February meeting, left for us the explanation of a paradox. Having derived a general formula for the middle reaction of a simply-supported, uniformly-loaded, horizontally-curved beam in terms of its radius and central angle, he computed the limit of the formula as the radius increased infinitely and the beam became straight. This limit was $\frac{4}{3}wL$ instead of the accepted $\frac{5}{4}wL$.

"Since the busy Navy can't spare him tonight, I'll try to judge your answers from his viewpoint. Has anyone an explanation for the dilemma?"

"Seriously," spoke up Ken Bridgewater, "I think that he started with an inflexible curved beam, that the rigidity was not relaxed when the limit was approached, and that the paradox involves comparison of an inflexible beam with an elastic one. But I suppose the right answer has to be funny!"

Then Bardie Taylor raised his hand. "Professor Neare, that first equation could have been set up just the same if the curved beam had been hinged at the center support. Also, a constant section wasn't specified, so that one span might be twice as stiff as the other. With such variations, the center reaction of the straight beam could range from wL to $2wL$, and the paradox can be as versatile as you please."

"I can't argue with either of you," replied the Professor. "Professor Wise's explanation is similar to Bridgewater's, as he asserted that his first equation is valid and reasonably accurate for large central angles, but exact only if the beam is wholly rigid on point supports. For an elastic beam, a correction for deflection and torsion would become sensible as the radius increased and exactly account for the paradox.

"From an idealistic philosophy, he accounted for the dilemma by noting that he had not proved that a straight beam was the limiting case of a circular beam instead, say, of a parabolic or sinusoidal beam. If we apply the same processes to a beam of either of these shapes we get different answers. Hence the plan form of a beam, for which a straight beam is the limiting case, is itself indeterminate. In a practical application, a 6% error is tolerable, but be sure to get the decimal point in the right place.

"And now for a more tangible problem, which I hope will intrigue you in spite of its practical application. It developed as an incident during construction of footings for a pier in Ken Bridgewater's Dunking Bridge. You tell it, Ken."

"All right, Noah. This pier was to be supported on pre-cast concrete piles, 100 ft in length and of constant section. The contractor cast them on his dock and proposed to use a three-point pick-up to transfer them to his barge. I tried to tell him that a four-point pick-up would be required, but he sent his efficiency engineer, Titus Wadhouse, to prove I was wrong.

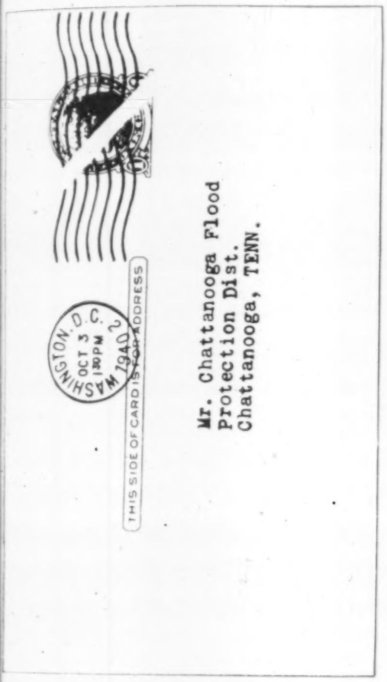
"Now Titus had a clever plan to so locate the three slings that the maximum bending moment in the pile was the least possible (and just permissible, so that the Titus Hitch is now a matter of history). I propose that you find where the three slings of the Titus Hitch were attached to each pile."

"Thank you, Ken, and I might add that the answer was a surprise to me."

(Professor Neare acknowledges receipt of many solutions to last August's problem of the Dictators and the Cocoanuts—all simpler than his. Without disparagement of the ingenuity shown, he notes that the problem was devised to illustrate the integral solution of the general equation:

$$Ax + By = C$$

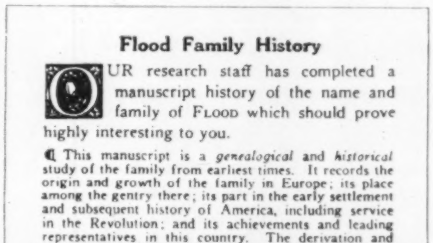
In this case, B could be made equal to 10,000 and the solution obtained by synthetic steps. In view of the interest in this type of problem, he promises another that will submit to the general method, but resist any but an inspired ingenuity.)



Mr. Chattanooga Flood
Protection Dist.
Chattanooga, TENN.

WASHINGTON, D.C. 2
OCT 3
1:30 PM
1940

THIS SIDE OF CARD IS FOR ADDRESS



Flood Family History

OUR research staff has completed a manuscript history of the name and family of FLOOD which should prove highly interesting to you.

¶ This manuscript is a *genealogical* and *historical* study of the family from earliest times. It records the origin and growth of the family in Europe; its place among the gentry there; its part in the early settlement and subsequent history of America, including service in the Revolution; and its achievements and leading representatives in this country. The derivation and meaning of the name are traced; recurrent family traits are brought out; and genealogical data on various lines are set forth. A valuable bibliography is included, as well as the authoritative description of a FLOOD coat of arms.

¶ The manuscript has been compiled from the most authentic sources. Reproduced on fine paper and bound in a handsome black

A Genealogy That Is "All Wet"

A MEMBER of the Society, E. L. Chandler, chief engineer of the Chattanooga Flood Protection District, recently received a communication that interested him strangely—the postcard reproduced herewith. In reply to this rather surprising bit of mail, he wrote a letter from which the following is quoted. Members interested in genealogy, as well as those who are not, may derive amusement from Mr. Chandler's account of an engineering family of troublemakers, by no means confined to Chattanooga.

—Research Bureau
Washington, D.C.

Dear Sirs:

Your postcard addressed to Mr. Chattanooga Flood, relative to the Flood family history, has been referred to me. However, I don't believe you can tell half as much about the Floods of Chattanooga as I can.

I imagine that you trace the Floods right back in a straight line to the days of Noah. If so, you make a grave error. Their true lineage is much more involved. For your information, I send you, without charge, the following data which have been prepared in the office of

Chattanooga Flood
Protection District
Chattanooga, Tenn.

In following back to the true source of the Chattanooga Floods one runs immediately into the Rivers. Incidentally, this has nothing to do with Governor Rivers, so far as we know. He may be connected, but the best known representative of recent generations is "Ol' Man," whose knowledge and wisdom have been so splendidly recorded in song.

It is a simple matter to follow back from the Rivers to the Brooks and the Creeks. It may be from the Creeks that an Indian strain got into the family, and it is thus that we account for an occasional reddish hue in the Chattanooga Floods.

Of course, the farther back one goes the broader the search, but it is not too difficult to follow the Brooks and Creeks back to the Springs and Marshes on the one hand, and to the Lakes and Ponds on the other. These are closely associated with the Dales and the Hills, and the latter form a branch of the family to which we refer with pride. Here there has always been close and beautiful coordination. It is just about axiomatic that wherever you find two Hills you will find at least one Dale. Hill N. Dale is familiar to every student of literature.

Returning again to the direct line we find that the Ponds, Lakes, Springs, and Marshes all originate from the Watters, and it is here that some confusion and difference of opinion may arise as to which sources should be given consideration in studying the Chattanooga Floods. The predominating influence is found in the Rains and Snows and they, in turn, are closely allied with the Storms and the Tempests. Minor influence may be credited to the Frosts and to the Dewey Fields, but I am not inclined to give them very much weight.

The Rains and Snows descend directly from the Clouds and Skyes. I know of no controversy about this.

Following back another step we find that the whole line stems from the Sun family to which all the Stars probably belong. The Moon influence must not be entirely ignored, but we consider it to be secondary. Perhaps worthy Dr. Yat Sen may be claimed among the kin, but it is probably better not to try to link so good a man to the Chattanooga Floods. However, there is a definite yellow in most of the Floods of Chattanooga.

You will note from the signature at the end of this letter that I am pretty closely associated with the Floods and I am going to tell you a little inside story about them. In the first place, thinking Chattanoogans are not at all proud of the history of the Chattanooga Floods. They are a lawless lot. They have always operated destructively and with ruthless disregard for the constitutionally guaranteed right of Chattanooga citizens to life, liberty, and the pursuit of happiness. Efforts are being made now to get the Floods under control and if they are not successful I make the confident prediction that some day Chattanooga will be just a washout.

For a number of years there has been a movement on foot to work with the Woods, Forests, Bushes, and their relations in an effort to check the destructive activities of the Floods. After long consideration, I am convinced that such efforts have little effect. The only way to keep the Floods of Chattanooga within proper bounds is by suitably coordinated action of the Banks and Walls and Gates. It has been a long battle to bring the people of the community to a realization of this fact, but the situation is better understood now than ever before and I trust we are on the way to early success.

Genealogically yours,

E. L. CHANDLER, *Engineer for*
Chattanooga Flood
Protection District

Guide to Library Facilities for National Defense

A CATALOGUE carrying the title given this item has been recently issued by the "Joint Committee on Library Research Facilities for the National Emergency" of the American Library Association. The purpose of the catalogue is to list the special and public libraries and institutions throughout the country that are known to have collections of technical material on defense subjects.

About forty such defense subjects constitute the main divisions of the index. Such headings as Aeronautics, Engineering, Explosives, Foreign Relations, Maps, Metallurgy, Transportation, and War Contracts are included. Under each heading the appropriate libraries or institutions are grouped according to geographical regions of the United States, such as Northeastern, Middle Atlantic, or Pacific Central. The material available at each institution is briefly characterized as to extent and scope. The catalogue as now issued is a preliminary edition. It can be had from the American Library Association, Chicago, Ill., for $1.25.

Official Defense Bulletin Issued by National Defense Advisory Commission

A WEEKLY SUMMARY of plans, changes, contracts, production, and many other facts relating to the rapid developments in the defense program will be of interest to all engineers who are watching progress of the work in relation to their own projects. Published by the National Defense Advisory Commission, the bulletin entitled "Defense" may be had from the Superintendent of Documents for 75 cents a year.

Illustrative of the scope of the bulletin are the following titles chosen at random from one issue: "Summary of the Week in Defense," "Operation of the Priorities System," "First AT-8 Plane," "Defense Housing," "Defense Purchases," "Compilation of Contracts Cleared and Awarded," "Coordinating Rail, Motor, Water, Pipeline Facilities." The issue carries about 15 pages.

Brief Notes

TO TAKE UP the employment slack after the war, the administration is building up a reservoir of public works projects. The kind of project contemplated might include such items as a new highway between Washington and Baltimore or a longer one that might go the length of the Atlantic coast. Authorization for such projects without appropriation may be requested now and from time to time in the future, and the plans may then be filed away until such time as they are needed.

* * * *

"PREPARATION of Structural Steel Surfaces for Painting" is the title of a pamphlet published by the American Institute of Steel Construction and describing the proceedings of a meeting held at its Annual Convention last fall. Flame cleaning, inaccessible surfaces, paints, and exposures are among the subjects included. There is also a table of "Painting and Paint Maintenance" costs.

* * * *

A FEW extra copies of the Society's pamphlet, "Biography of Ralph Budd," winner of the John Fritz Medal in 1941, are available at Society Headquarters for distribution on request.

* * * *

A THREE-DAY special course on soil engineering will be held at Michigan State College, March 3, 4, and 5, under the joint auspices of the Civil Engineering Department, the college Short Course Department, and the Michigan State Highway Department. The soil geology of Michigan, soil classification, soil surveys, soil performance under natural conditions, soil characteristics and their determination, practical use of soil data in highway design, soil mechanics, and soil stabilization will be the subjects of discussion.

* * * *

SPEAKING on national defense before the engineering groups in Syracuse recently, William A. Hanley, President of the American Society of Mechanical Engineers, advocated graduation of the engineering classes of 1942 at least three months in advance of the regular date. Fourteen thousand engineers will graduate from universities in the United States in 1941, but many more will be needed. He suggested that the engineering schools continue through the summer months with intensive study so that the class of 1942 can be graduated in February of that year.

* * * *

NOW available at the office of the Superintendent of Documents is the fall edition of the U. S. Government Manual. Organization of government agencies, changes, publications, and other data will be useful to those working on federal projects.

NEWS OF ENGINEERS

Personal Items About Society Members

MEMBERS of the Society in the Officers Reserve Corps of the Army who have recently been ordered to report for active duty are Lt. Col. Claude M. Cade from professor of civil engineering at Michigan State College to executive officer in the Coast Artillery Corps at Lansing, Mich.; Maj. David E. Donley from civilian hydraulic engineer in the Washington District of the U.S. Engineer Department, to the Corps of Engineers, U.S. Army, temporarily assigned as a student at the Army Industrial College, Washington, D.C.; Capt. John J. Ledbetter, Jr., from assistant counsel, U.S. Section, International Boundary Commission, to Labor Relations Officer on the staff of the Zone Constructing Quartermaster at San Antonio, Tex.; Capt. Horace G. Nave from junior highway engineer for the TVA at Murphy, N.C., to active duty at Fort Belvoir, Va.; Capt. Werner C. Strecker from assistant district executive for the Schenectady (N.Y.) District of the CCC, to executive officer on the staff of the Constructing Quartermaster of the St. Louis Ordnance Plant at St. Louis, Mo.; and Lt. Benjamin C. Seal from Grand Rapids, Mich., to Assistant Constructing Quartermaster of the St. Louis Ordnance Plant.

O. NEIL OLSON, for the past seven years instructor in civil engineering at Marquette University, has been appointed assistant professor and acting head of the department of civil engineering.

H. G. SOURS, Ohio state director of highways, has been commissioned by Secretary of State Hull as United States representative on the Permanent International Commission of the Permanent International Association of Road Congresses.

H. G. GERDES, captain, Corps of Engineers, U.S. Army, was recently named military assistant in charge of construction of the new army air base being built at Charlotte, N.C.

JAMES I. BALLARD has returned to New York and the staff of *Engineering News-Record* in the capacity of managing editor. Mr. Ballard first became connected with that publication in 1929, but left it in 1935 to assume the editorship of *Western Construction News*.

L. W. ALTHOF, formerly division engineer for the Union Pacific at Portland, Ore., has been promoted to the position of district engineer of the Eastern division, with headquarters at Omaha, Nebr.

DANIEL NOCE, lieutenant colonel, Corps of Engineers, U.S. Army, has been ordered to training duty at Rolla, Mo. Until lately Colonel Noce was district engineer for the U.S. Engineer Office at Memphis, Tenn.

F. B. FARQUHARSON has been granted a leave of absence from his duties as associate professor of civil engineering at the University of Washington in order to continue his studies of the failure of the Tacoma Bridge by models and in the field.

W. G. BRENNEKE was recently appointed resident engineer for the Connecticut State Highway Department in charge of the construction of the Thames River Bridge at New London, Conn. For the past five years Mr. Brenneke has been resident engineer inspector for the PWA in Connecticut.

PERCY H. BLISS has resigned as junior engineer in the U.S. Engineer Office at Little Rock, Ark., in order to accept a position as assistant engineer in the Denver office of the U.S. Bureau of Reclamation. He will be engaged on designs for the Marshall Ford Dam, under construction in Texas.

PAUL G. CROUT announces that he is now associated with HOWARD L. CRANDALL and CHARLES W. SNYDER in the structural engineering firm of Crout, Snyder and Crandall, with headquarters at 20 East Lexington Street, Baltimore, Md.

F. H. Frankland has been made director of engineering of the American Institute of Steel Construction, and will devote himself to technical research in the use of structural steel and to other engineering matters with which the Institute is concerned. Previously Mr. Frankland was chief engineer.

O. E. Hager, formerly designing engineer for the New York, Chicago and St. Louis Railroad, is now engineer of bridges and structures for the Pere Marquette Railway Company, with headquarters in Detroit, Mich. He succeeds **C. S. Sheldon** who has retired after many years of service.

Max Schlesinger has resigned as assistant highway engineer in the Bureau of Bridges of the Illinois Division of Highways in order to accept a position as structural designer with the A. G. McKee Company, engineers and contractors of Cleveland, Ohio.

F. C. Boggs, Colonel, Corps of Engineers, U.S. Army (retired), has been recalled to active duty and stationed at the U.S. Engineer Office at Baltimore, Md.

Schuyler M. Smith recently accepted a position as structural engineer with the Gulf, Mobile and Ohio Railroad, with headquarters at Mobile, Ala.

Edgar A. Groves has been promoted from the position of director of the Richmond Field Office of the WPA to that of manager of the Manhattan (New York) District Office.

Edward H. Harris has resigned as resident engineer with the State Highway Board of Georgia in order to accept the position of assistant district superintendent of District 4 of the WPA, with offices in Marietta, Ga.

Brehon B. Somervell has been promoted from the rank of lieutenant colonel in the Corps of Engineers to that of brigadier general in connection with his recent assumption of the duties of Chief of the Construction Division in the office of the Quartermaster General.

Herbert S. Hicks, formerly with Jerome A. Utley, general contractor of Detroit, Mich., has accepted a position as sales engineer in charge of all field work, with the Precast Unit Company, of the same city.

Charles L. Hall, Colonel, Corps of Engineers, U.S. Army, has been released from duty as district engineer for the New York District of the U.S. Engineer Office and ordered to duty in the office of the Chief of Engineers, U.S. Army, Washington, D.C. Lt. Col. **Lee S. Dillon** will replace him as district engineer at New York.

J. F. Kunesh, after three years as director of the Territorial Planning Board of Hawaii, has been appointed to serve as chief engineer of the City and County of Honolulu.

DECEASED

Edward Russell Allen (Assoc. M. '35) resident engineer for the J. E. Greiner Company, of Baltimore, Md., died on January 26, 1941, as the result of injuries received in an automobile accident. Mr. Allen, who was 35, had been with the J. E. Greiner Company in various capacities since 1926. At the time of his death he was project engineer in charge of construction of the cantonment being erected at Fort Meade, Md.

Robert Goodlive Bainter (Jun. '39) general plant inspector for the Bureau of Tests of the Ohio State Highway Department, died at his home in Columbus, Ohio, on January 1, 1941. He was 26. Mr. Bainter, a graduate of Ohio State University, had been in the Bureau of Tests since 1938. Before that (1935 to 1938) he was in the U.S. Engineer Office at Zanesville.

John Cantley (Assoc. M. '16) structural engineer for the City of Philadelphia, Pa., died there on January 11, 1941, at the age of 66. Mr. Cantley had been in the Bureau of Building Inspection of the City of Philadelphia for the past twenty-eight years.

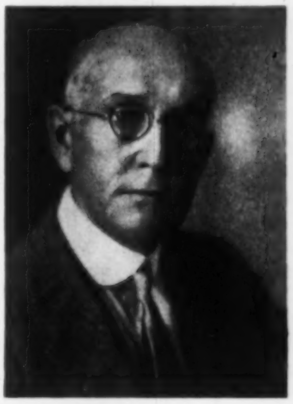
Fred Gaston Cunningham (M. '26) consulting engineer of New York City, died at Fairfield, Conn., on January 26, 1941, at the age of 54. From 1911 to 1914 Mr. Cunningham was resident engineer and, later, chief draftsman for the W. J. Sherman Company, of Toledo, and from 1914 to 1921 with William G. Clark, of Toledo. In the latter year he became connected with the firm of Fuller and McClintock, of which he was the last surviving partner.

George Stokes Fanning (M. '40) chief engineer of the Erie Railroad, Cleveland, Ohio, died suddenly on January 2, 1941, at the age of 55. From 1906 to 1910 Mr. Fanning was assistant engineer for the Michigan Central Railroad, and from 1910 to 1913 resident engineer for the Algoma Eastern and Algoma Central and Hudson Bay Railways. From the latter year on he was with the Erie.

Julian Clarence Feild (M. '17) president of the Julian C. Feild Company, at Denison, Tex., died there on December 22, 1940. Mr. Feild, who was 59, maintained a consulting practice in Denison from 1907 to the time of his death. During this period he served as consultant to various county, state, and commercial organizations and, for a time also, was city engineer of Denison.

Frederick Elbert Field (M. '10) division engineer for the Montreal (Canada) Water Board, died in that city on January 27, 1941. He was 67. A native of the United States, Mr. Field went to Montreal twenty-eight years ago to help organize a water-filtration system for the city, and had remained on the staff of the Water Board since that time.

Henry Goldmark (M. '88) retired civil engineer, died at Nyack, N.Y., on January 15, 1941, of injuries resulting from being struck by an automobile. He was 83. One of the first to use steel in bridge construction, Mr. Goldmark designed and built bridges for several railroads. From 1906 to 1914 he was engaged in the design, construction, and installation of the lock gates for the Panama Canal. Later he maintained a consulting practice in New York. The important projects with which he was connected included the design of the harbor equipment for the Japanese government at Chemulpo, Korea, and of the Inner Navigation Canal at New Orleans, and work on the Passamaquoddy Project.


John B. Hawley

John Blackstock Hawley (M. '98) consulting engineer of Fort Worth, Tex., died there on January 9, 1941, at the age of 74. Major Hawley was city engineer of Fort Worth from 1897 to 1907, and president of the General Construction Company from 1909 to 1917. From 1920 on he was associated with several firms, the most recent being Hawley, Freese and Nichols. The latter connection was terminated in 1938 when Major Hawley opened his own office. During the World War he served overseas with the rank of major, commanding the 503d Engineers. He was, also, engineer in charge of water supply and sanitation of Base Section No. 1 on the Western Front. Long active in the affairs of the Society, Major Hawley served as Director from 1915 to 1917.

Bernard Phillip Hessler (M. '29) for many years connected with the consulting firm of Wilberding Company, Inc. (and its predecessors), Washington, D.C., died recently. Mr. Hessler, who held the position of vice-president at the time of his death, was 51.

John Joseph McGinley (Assoc. M. '23) assistant engineer in the New York City Department of Public Works, died on December 9, 1940, at the age of 51. From 1914 to 1918 Mr. McGinley was with the New York State Public Service Commission, and from 1919 to 1922 structural designer for the Texas Company in New York City. In the latter year he became connected with the New York City Department of Plant and Structures (now Public Works). During the war

Mr. McGinley served as a second lieutenant in the U.S. Air Service.

NORMAN ROOSEVELT MCLURE (M. '12) since 1922 vice-president of E. J. Lavino and Company, Philadelphia, Pa., died suddenly at his home at Radnor, Pa., on January 21, 1941. He was 61. From 1905 to 1907 Mr. McLure was inspector in charge of erection of the Quebec Bridge, and from 1907 to 1917 he was with the Phoenix Iron Company—for the last four years as chief engineer. Later he was with the Tioga Steel and Iron Company, and the Philadelphia Roll and Machine Company.

CLINTON KENNETH MASON (Assoc. M. '38) divisional construction engineer for the New Hampshire State Highway Department, died at Keene, N.H., on February 1, 1940, though word of his death has just reached the Society. Mr. Mason, who was 36, had been with the highway department since 1935. Earlier he had worked for several road companies in New England and, at one time, was in Florida. He was the inventor of a new type of road hone, which attracted much attention.

ROY EZEKIEL NELSON (Assoc. M. '39) assistant professor of railway and highway engineering at West Virginia University, Morgantown, W.Va., died on January 7, 1941. He was 51. Mr. Nelson was instructor in surveying at West Virginia University from 1921 to 1925, and assistant professor of railway and highway engineering from 1925 on. During the war he served with the A.E.F. in France, with the rank of second lieutenant.

THOMAS FITCH ROWLAND, JR. (M. '86) retired civil engineer of Brooklyn, N.Y., died some time ago, though the Society has just learned of his death. Mr. Rowland was, for many years, connected with the Continental Iron Works, of Brooklyn—first as secretary and treasurer and, later, as president. He was the son of the late Thomas Fitch Rowland, Honorary Member of the Society, in whose honor the Society established the Thomas Fitch Rowland Prize in 1882.

WILLIAM LAWRIE STEVENSON (M. '18) director of the Bureau of Engineering of the Pennsylvania State Department of Health, Harrisburg, Pa., died in that city on January 4, 1941. He was 64. Except for a brief period with Metcalf and Eddy, of Boston, Mr. Stevenson had been with the Pennsylvania Department of Health since 1919. Before that (1908 to 1918) as engineer in charge of sewage disposal for the Philadelphia Department of Public Works, he prepared a comprehensive plan for the collection, treatment, and disposal of Philadelphia sewage.

LEWIS BUCKLEY STILLWELL (M. '01) of Princeton, N.J., died in Baltimore, Md., on January 19, 1941, at the age of 77. From 1885 to 1900 Mr. Stillwell was with the Westinghouse Electric and Manufacturing Company—part of the time as chief electrical engineer. From 1900 until his retirement in 1938 he maintained a consulting practice in New York. During this period he served as consultant on the electrification of the elevated and subway lines in New York, the Holland Tunnel, and many other important projects. He was also noted for advancing the use of alternating current. Mr. Stillwell was the recipient of both the Edison and Lamme Medals of the American Institute of Electrical Engineers, which he had served as president.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

HARRY EDGAR TROUT (M. '13) general superintendent of the Conemaugh and Black Lick Railroad Company, Johnstown, Pa., died on January 15, 1941. Mr. Trout had been with the Conemaugh and Black Lick Railroad for a number of years, and at one time was vice-president. Earlier in his career he was superintendent of transportation for the Cambria Steel Company, of Johnstown.

WALTER LORING WEBB (M. '04) author of several books on railroad construction, died at his home at Lansdowne, Pa., on January 24, 1941. He was 77. Mr. Webb had been on the civil engineering staffs of Cornell University and the University of Pennsylvania. At one time he was chief engineer of Day and Zimmermann, of Philadelphia, and he had also been with the U.S. Geological Survey and the U.S. Engineer Corps. During the war he served with the A.E.F. in France, with the rank of major.

HERBERT CASSIDY WELLS (Assoc. M. '13) U.S. senior highway engineer for the Public Roads Administration at Montgomery, Ala., died recently. He was about 56. Mr. Wells was engaged on road construction in New York State from 1903 to 1909. He then joined the staff of the U.S. Bureau of Public Roads (now the Public Roads Administration) and served as superintendent of road construction in Washington, D.C., before going to Alabama.

LESLIE CLIFFORD WHITTEMORE (M. '21) chief engineer of design for the Sanitary District of Chicago (Ill.), died on January 13, 1941, at the age of 55. Mr. Whittemore was with the Massachusetts State Board of Health from 1907 to 1909, and with the New York Board of Water Supply from 1909 to 1912. In the latter year he became connected with the Sanitary District of Chicago, working up through the various departments to become chief engineer in 1925.

[*Editor's Note:* In the first copies of the February number that were printed the death of C. C. Hurlbut, M. Am. Soc. C.E., was erroneously announced, due to incorrect information mistaking him for another man of similar name and address. Mr. Hurlbut is a life member, now on the staff of F. R. Harris, Inc., of New York City.]

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From January 10 to February 10, 1941, Inclusive

ADDITIONS TO MEMBERSHIP

ABBEY, ROBERT JEROME (Jun. '40), Laboratory Asst., Materials Testing Laboratory, State Bureau of Highways, 27th and Main St. (Res., 1206 North 5th St.), Boise, Idaho.

BAIL, ERNEST BENJAMIN (M. '40), Engr., Plans and Surveys, State Highway Dept., Santa Fe (Res., 211 South Dartmouth, Albuquerque), N.Mex.

BARNETT, THOMAS CHARLES (Jun. '41), Junior Engr., Cia Bananera de Costa Rica, San Jose, Costa Rica.

BEDENIK, JACOB JAMES (Jun. '41), Insp., U.S. Engrs., 408 Federal Bldg. (Res., 1238 West Madison St.), Milwaukee, Wis.

BEER, CHARLES GROVER (Jun. '40), Senior Eng. Aid, State Div. of Highways, Box 1352, Fresno, Calif.

BIRDSALL, JOHN WILBUR (Jun. '41), Engrs. Aid, Chf. of Party, SCS, U.S. Dept. of Agriculture, Pembroke, Ga.

BITTENBRING, CHARLES, JR. (Jun. '40), Junior Engr., Humble Oil & Refining Co., H-74, Houston, Tex. (Res., 407 Highway Drive, New Orleans, La.)

BLISS, ROBERT T. (Jun. '40), With Western Industrial Eng. Co., 2223 East 37th St. (Res., 824 South Orange Grove Ave.), Los Angeles, Calif.

BOOK, STANLEY FINLEY (Jun. '40), Detailer, Am. Bridge Co. (Res., 532 Park Rd.), Ambridge, Pa.

BOUDON, PLACER (Jun. '40), Civ. Engr., Federal Shipbuilding & Drydock Co., Kearny, N.J. (Res., 1028 Seventieth St., Brooklyn, N.Y.)

BOWERS, WILLIAM C. (Jun. '40), Structural Designer, Arundel Corp. and Con. Eng. Co., Inc., San Juan, Puerto Rico

BOWMAN, JAMES WILLIAM (Jun. '40), Draftsman, Illinois Central R.R., Room 706 Central Station (Res., Croyden Hotel, Room 517), Chicago, Ill.

BOWMAN, JOSEPH RICHMOND (Jun. '41), Junior Engr. (Civ.), Hydr. Section, War Dept., U.S. Engr. Office, Flatiron Bldg., Norfolk, Va.

BOYD, HAROLD WALTER (Jun. '40), Sanitarian, State Board of Health, R.F.D. 1, Thorntown, Ind.

BREIHAN, ERWIN ROBERT (Jun. '40), Junior Engr., Mavran, Russell, Crowell & Mullgardt, 1161 Paul Brown Bldg. (Res., 5136 Heege Ave.), St. Louis, Mo.

Brewster, George Colby (Assoc. M. '41), Civ. Engr., Black & Veatch, 4706 Broadway, Kansas City, Mo.

Buchta, Marion Arthur (Jun. '41), Student Test Engr., Gen. Elec. Co., 1 River Rd., Schenectady, N.Y.

Budnik, Cass A. (Assoc. M. '41), Tunnel Res. Engr., Pennsylvania Turnpike Comm., Everett (Res., 531 West Main St., Somerset), Pa.

Burnett, John Hugh (Jun. '40), Sales Representative, Burnett Brothers & Hamill, Inc., Box 433, Tampa, Fla.

Bush, Alfred (Jun. '41), With Frank Lloyd Wright, Box 551, Phoenix, Ariz.

Carroll, Richard Westley (Jun. '40), Junior Naval Archt., U.S. Navy Dept., Norfolk Navy Yard (Res., 58 Court St.), Portsmouth, Va.

Cataldo, Henry (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, Dept. of Interior, Security Bank Bldg. (Res., 1024 North 30th St.), Billings, Mont.

Clayton, Frederick William (Jun. '41), Junior Engr. (Hydr. Design), Div. of Conservation and Development, City Water Dept., Room 269, Civic Center (Res., 1269 Lincoln Ave.), San Diego, Calif.

Clevenger, Oliver Loomis (Jun. '40), Junior Engr., Humble Oil & Refining Co., Baytown, Tex.

Compton, Robert Hayes (Jun. '40), With Aluminum Co. of America, 5151 Magnolia, Los Angeles (Res., 6418 A Benson St., Huntington Park), Calif.

Conway, Lee Franklin (Jun. '41), 217 Prairie, Aurora, Ill.

Cornell, Arthur Roscoe (Jun. '40), With Eng. Dept., Am. Steel & Wire Co., Rockefeller Bldg. (Res., 3330 Glencairn Rd., Shaker Heights), Cleveland, Ohio.

Cox, Charles William (Jun. '40), Junior Engr. (Constr.), War Dept., Quartermaster Corps, Ordnance Works, Charlestown (Res., 1816 East Market St., New Albany), Ind.

Cragwall, Joseph Samuel, Jr. (Jun. '40), Eng. Draftsman (Maintenance), The Solvay Process Co., Hopewell, Va.

Czaja, Edwin Paul (Jun. '40), Eng. Draftsman, Truscon Steel Co., Albert St. (Res., 1334 Kensington Ave.), Youngstown, Ohio.

Darby, Mitchell (Assoc. M. '41), Pres., Mitchell Darby, Inc., 3615 Leeland St., Houston, Tex.

Dawson, Jay Bosworth (M. '41), Div. Engr., S. P. Co., 3d and Townsend Station, San Francisco, Calif.

Decker, Sherman Oliver (Assoc. M. '40), Asst. Engr. (Hydr.), U.S. Geological Survey, Box 831, Yuma, Ariz.

Delp, LaRue Eldred (Jun. '40), Junior Engr., Grade B, State Highway Comm., Norton (Res., Lenora), Kans.

Dietz, Olen Adolph (Assoc. M. '40), Asst. Engr., Municipal Eng. Div., Ancon, Canal Zone.

Dougherty, James Edward Joseph, Jr. (Jun. '40), Aeronautical Designer and Stress Analyst, Brewster Aeronautical Corp., Long Island City (Res., 2600 Davidson Ave., New York), N.Y.

Dougherty, William Joseph, Jr. (Jun. '40), Civ. and Aeronautical Engr., Estimate Div., Brewster Aircraft Co., Northern Blvd., Long Island City (Res., 138 West 180th St., New York), N.Y.

Drescher, William James (Jun. '40), Engr., Am. Bridge Co. (Res., 405 Bridge St.), Gary, Ind.

Dunham, Dick Roland (Jun. '40), Field Engr., Chemical Div., Pittsburgh Plate Glass (Res., 184 Sixth St., N.W.), Barberton, Ohio.

Eberlin, Monroe Marshall (Jun. '40), Draftsman, Fort Greene Houses, Section 3, Associated Archts., 25 West 45th St. (Res., 915 West End Ave.), New York, N.Y.

Eddy, Robert William (Jun. '40), Bridge Insp., State Highway Dept., State Bldg., Lansing (Res., 220 Kenwood Ave., Ann Arbor), Mich.

Ellis, Richard Bourne (Jun. '40), Asst. Eng. Draftsman, U.S. Navy Yard, Bldg. 8 (Res., Y.M.C.A.), Charleston, S.C.

Engler, Albert Ernest (Jun. '40), Junior Engr., Quartermaster Corps, War Dept., Ordnance Plant, Ravenna (Res., 12103 Lorain Ave., Cleveland), Ohio.

Flowers, Fred Fort (Jun. '41), Mass. Inst. Tech., 521-A Graduate House, Cambridge, Mass.

Follestad, Ralph Christian, Jr. (Jun. '40), Rating Examiner, CAF-4, U.S. Civ. Service, 320 Post Office Bldg. (Res., 108 North 101st St.), Seattle, Wash.

Fox, John Clayton (Jun. '40), Chf. of Party, Layout Crew, E. I. du Pont de Nemours, Charlestown, Ind. (Res., 98 Main St., Fort Plain, N.Y.)

Frazier, John Proper (M. '41), Chf. Engr., Harrison Constr. Co., 1101 Western Ave. (Res., 3660 Harbison St.), Pittsburgh, Pa.

Fremon, John Leon (Jun. '40), Field Engr., R. G. LeTourneau, Inc., Peoria, Ill.

Gant, Edward Victor (Jun. '40), Structural Detailer, Am. Bridge Co., Ft. of Warren St. (Res., 2 South Clinton Ave.), Trenton, N.J.

Gibbs, Harold Joseph (Jun. '40), Research Asst., Civ. Eng., Univ. of Missouri, Civ. Eng. Bldg. (Res., 1313 Rosemary Lane), Columbia, Mo.

Gibson, William Roland (Jun. '41), Structural Draftsman, Am. Bridge Co., Ft. of Warren St. (Res., 63 Maple Ave.), Trenton, N.J.

Gifft, Howard Merrill (Assoc. M. '40), Instr., Iowa State College, 404 Eng. Bldg., Ames, Iowa.

Gover, Jesse (Assoc. M. '40), Designer, Office of Engr. of Structures, Erie R.R., 738 Midland Bldg. (Res., 3321 Tullamore Rd., Cleveland Heights), Cleveland, Ohio.

Graber, Ralph Carl (Jun. '40), Draftsman, Div. Engr. Office, P.R.R., Harrisburg (Res., 473 Main St., Collegeville), Pa.

Greenleaf, Lee Moses (Assoc. M. '41), Civ. Engr., Nantahala Power & Light Co., Box 938, Sylva, N.C.

Haley, George Malen (Assoc. M. '40), County Engr. and Surveyor, Salt Lake County, 306 City and County Bldg. (Res., 145 Edith Ave.), Salt Lake City, Utah.

Hamilton, William Anderson, Jr. (Jun. '40), With Mosher Steel Co., Washington St. (Res., 2205 North Blvd.), Houston, Tex.

Hanks, George Fredrick (Jun. '40), Detailer, Am. Bridge Co. (Res., 4 Glenwood Ave.), Ambridge, Pa.

Hansen, Arnold Melvin (Jun. '40), 2 Gorham St., Cambridge, Mass.

Harris, Robert Blynn (Jun. '40), Detailing Draftsman, Am. Bridge Co. (Res., 212 Kensington Ave.), Trenton, N.J.

Heath, Woodson Fearing (M. '41), Asst. Engr. in Chg., R. of W., International Boundary Comm., United States and Mexico, San Benito, Tex.

Heiple, Loren Ray (Jun. '40), With International Filter Co., 325 West 25th Pl., Chicago (Res., 224 West North St., Hinsdale), Ill.

Hekkanen, Toivo Ernest (Jun. '40), Eng. Draftsman, Puget Sound Navy Yard (Res., 511 Twelfth St.), Bremerton, Wash.

Henck, Joseph Putnam (Jun. '40), Skyforest, Calif.

Hill, Gordon Eugene (Jun. '40), Eng. Aid, TVA, Commercial Bank Bldg. (Res., 209 South Blakemore St.), Paris, Tenn.

Hill, Herndon Shuler (Jun. '40), Eng. Draftsman, U.S. Dept. of Interior, Bonneville Power Administration, 1300 North East Union Ave., Portland, Ore.

Hinshaw, Conrad Schwartz (Jun. '40), Surveyor, Continental Oil Co., Box 3126, Houston, Tex.

Honnold, Harold Leland, Jr. (Jun. '40), Instrumentman, S. P. Co., 3d and Townsend Sts., Room 214, San Francisco (Res., 2267 Summer St., Berkeley), Calif.

Horner, James Russell (Jun. '40), Insp., State Highway Dept, Lansing (Res., 1220 Grand Traverse, Flint), Mich.

Huggins, Harwell Steed (Jun. '40), Asst. to Div. Engr., Seaboard Air Line Ry. (Res., 115 Main St.), Hamlet, N.C.

Hunt, Charles William (Jun. '40), Junior Highway Engr., Public Roads Administration, 254 New Customhouse (Res., Y.M.C.A.), Denver, Colo

Iller, Werner Jacob (Jun. '40), Box 1039, West Lafayette, Ind.

Ivancovich, Wayne William (Jun. '40), Surveyor, Western Geophysical Co., Los Angeles (Res., 135 Normandy Ave., Hanford), Calif.

Jeans, Robert Lee (Assoc. M. '40), Associate Civ. Engr., TVA, Watts Bar Dam, Tenn.

Jivrajani, Prabhudas Ranchhordas (Assoc. M. '40), Asst. Engr., Public Works Dept., Sind, Karachi, India.

Johnson, Cort Thomas (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, 313 North 3d Ave., Phoenix, Ariz.

Johnson, Robert Linder, Jr. (Jun. '40), Tracer, Wiedeman & Singleton, Fort McClellan, Ala. (Res., 1305 North Broad St. Rome, Ga.)

Jollie, Walter Harold (Jun. '40), Asst. San. Engr., State Dept. of Public Health, 216½ East Monroe St. (Res., 812 South 4th St.), Springfield, Ill.

Jones, Joseph Vincent (Jun. '40), Mech. Designer, Gen. Elec. Co., 6901 Elmwood Ave. (Res., 6[illegible]21 Grays Ave.), Philadelphia, Pa.

Kany, Robert Carl (Jun. '40), Junior Engr., Water Resources Branch, U.S. Geological Survey, 511 Board of Trade Bldg., Indianapolis, Ind.

Kaskel, John Theodore (Jun. '40), 561 Fourth St., Troy, N.Y.

Keller, Harry Otto (Jun. '40), (Casey & Keller), 1000 Springfield Ave., Irvington, N.J.

Kneeland, William Frederick (Jun. '41), Research Asst., Eng. Experiment Station, Iowa State College (Res., 247 Hyland), Ames, Iowa.

Lagarde, Paul Michinard (Jun. '40), Tactical Officer, Marion Inst., Marion, Ala.

Lee, Allan (Assoc. M. '41), Asst. Engr., State Roads Comm., Federal Reserve Bank Bldg. (Res., 923 North Kresson St.), Baltimore, Md.

Leonard, George Perry (Assoc. M. '41), Gen. Supt., Minneapolis Dredging Co., Martin Wunderlich Co., George P. Kingsley Dam, Ogallala, Nebr.

Lim, Phek Choo (Assoc. M. '40), Supt., Waste Detection, Singapore Municipality, Water Dept., Municipal Offices, Singapore.

Lubker, Robert Henry (Jun. '40), Bridge Draftsman, Bridge Dept., State Highway Comm. (Res., 716 West Pleasant Drive), Pierre, S.Dak.

Lucks, Lloyd Frederick (Assoc. M. '41), Land Appraiser, Assessor's Office, City and County of San Francisco, 101 City Hall (Res., 1343 Oak St.), San Francisco, Calif.

McMahon, William Willson (Jun. '40), Draftsman, Bridge Dept., Santa Fe R.R., Room 1243 Railway Exchange Bldg. (Res., 2044 Estes Ave.), Chicago, Ill.

Mann, Russell Philip (Jun. '40), Traffic Sign Designer, State Bureau of Highways, Highways Materials Laboratory (Res., 415 State St.), Boise, Idaho.

Maxwell, Joseph Russell (Jun. '40), Care, P.R.R., Williamsport, Pa.

Mead, Julian Curtis (M. '41), Chf. Bridge Designer, Board of Wayne County Road Commrs., 3800 Barlum Tower, Detroit (Res., 72 Chestnut St., Wyandotte), Mich.

Miller, Tyrus Sherman (Jun. '40), Junior Civ. Engr., Southern California Gas Co., 1700 South Santa Fe Ave., Los Angeles (Res., 1871 Woodlyn Rd., Pasadena), Calif.

Mitchell, William Henry (Jun. '40), Asst. Engr. (Structural), U.S. Engr. Office, 2d and Chestnut Sts., Philadelphia, Pa.

Mockevicz, Anthony John (Jun. '40), Foreman and Supervisor, C. W. Blakeslee & Sons, Inc., 80 Waverly St., New Haven (Res., 9 Montowese St., Branford), Conn.

Moreton, Harold Elmo (Jun. '40), Material Tester, U.S. Army Engr., Hill Field Military Reserve, Ogden, Utah. (Res., 133 East 1st South, Rexburg, Idaho.)

Morgan, Albert Rufus, Jr. (Jun. '40), Junior Naval Archt., U.S. Navy Yard (Res., 49 Church St.), Charleston, S.C.

Morton, Robert Norcross (Jun. '40), Junior Naval Archt., U.S.N., Mare Island Navy Yard (Res., 552 Wilson), Vallejo, Calif.

TOTAL MEMBERSHIP AS OF FEBRUARY 10, 1941

Members	5,665
Associate Members	6,538
Corporate Members	12,203
Honorary Members	35
Juniors	4,543
Affiliates	69
Fellows	1
Total	16,851

Morton, Russell Julius (Assoc. M. '41), Gen. Mgr., Chattahoochee Valley R.R., West Point, Ga.

Neill, Arthur Harry (Jun. '40), San. Engr., City of Rock Island, Sewage Treatment Plant (Res., 1918 Seventh Ave.), Rock Island, Ill.

Nishkian, Byron Leon (Jun. '40), Asst. Engr., Timber Testing Program, 405 Montgomery (Res., 75 Buena Vista Ave.), San Francisco, Calif.

Norris, George Edward (Assoc. M. '41), Field Engr., B. & R.R.R., 912 A Goff Bldg., Clarksburg, W.Va.

Occhipinti, Sebastian James (Jun. '41), Engr. (Structural), Jackson & Moreland, 31 St. James Ave., Boston (Res., 35 Thomas St., Medford), Mass.

Petersen, Theodore Denham (Jun. '40), Draftsman, Am. Bridge Co. (Res., 4 Glenwood Drive), Ambridge, Pa.

Posthumus, George (Jun. '40), 701 East 52d St., Los Angeles, Calif.

Pucci, Rocco Nicholas (Jun. '40), Mech. Designer, Gen. Elec., 6901 Elmwood Ave. (Res., 6521 Grays Ave.), Philadelphia, Pa.

Pulling, Ronald Wilson (Jun. '40), Junior Civ. Engr., Civ. Aeronautics Administration, Washington, D.C.

Reeves, William Quiggle (Jun. '40), Asst. Eng. Draftsman, U.S. Bureau of Reclamation, Kremmling, Colo.

Richey, Vernon Jay (Jun. '40), Junior Naval Archt., Industrial Dept., U.S. Navy, Pearl Harbor Navy Yard (Res., 2803 Leialoha Ave.), Honolulu, Hawaii.

Riker, Warren Newton (Assoc. M. '41), 42 Kenwood Rd., Tenafly, N.J.

Rodewald, Frederick Arthur (Assoc. M. '41), Senior Eng. Draftsman, International Boundary Comm., United States and Mexico, San Benito, Tex.

Roth, Nicholas Peter (Jun. '40), Draftsman, Am. Bridge Co. (Res., 4 Glenwood Drive), Ambridge, Pa.

Royce, Arthur Fredric (Jun. '40), Junior Naval Archt., Planning Div., U.S. Navy, Pearl Harbor Navy Yard (Res., 2803 Leialoha Ave.), Honolulu, Hawaii.

Rutter, Martin Luther (Jun. '40), Lt. (jg), C.E.C. U.S.N., Public Works Office, Parris Island, S.C.

Saffir, Herbert Seymour (Jun. '41), Junior Civ. Engr., National Advisory Committee for Aeronautics, Langley Field (Res., 130 Greenbriar Ave.), Hampton, Va.

Samuelson, Donald Anders (Jun. '40), Care, A. G. Samuelson Co., 320 South Clairmont, Springfield, Ohio.

Sanks, Robert Leland (Jun. '40), Civ. Eng. Asst., Alex M. Morrison, 719 North Spadra Ave., Fullerton (Res., 112 West Florence, La Habra), Calif.

Sapirie, Samuel Ralph (Assoc. M. '41) Civ. Engr., SCS, Region Office, U.S. Dept. of Agriculture, 4650 North Port Washington Rd. (Res., 5114 North Diversey Blvd.), Milwaukee, Wis.

Schlegel, James Paul (Jun. '40), Engr. Apprentice, P.R.R., Union Station, Chicago, Ill. (Res., 110 East 7th St., Marysville, Ohio.)

Schlinkman, Robert George (Jun. '40), Rodman, State Highway Dept. (Res., 1013 West Main), Clarksville, Tex.

Schmuller, Frederick Morris (Assoc. M. '40), Asst. Engr. (Design), Dept. of Public Works, 125 Worth St., New York, N.Y.

Schultes, August Charles, Jr. (Jun. '40), Asst. San. Engr., State Board of Health, 798 Market St., Meadville, Pa. (Res., 501 Mantua Ave., Woodbury, N.J.)

Seaworth, George Henry (Jun. '41), Structural Designer, State Highway Dept. (Res., 400 Sixth St.), Bismarck, N.Dak.

Seeland, Elias (Assoc. M. '41), Capt., Quartermaster Corps, U.S. Army, Office, Quartermaster Gen., Camp Blanding, Fla. (Res., 230 East 73d St., New York, N.Y.)

Smith, Marvin Schade (Assoc. M. '40), Asst. Engr., Panama Canal, S. I. P. 5, Gatun, Canal Zone.

Smith, Richard Kenneth (Jun. '40), Eng. Draftsman, City Eng. Dept., Municipal Bldg. (Res., 345 Delaware Ave.), Dayton, Ohio.

Stahl, John Vernon (Jun. '41), Laboratory Asst., Underwriters Laboratories, 207 East Ohio St. (Res., 5646 Ridge Ave.), Chicago, Ill.

Stermitz, Frank (Assoc. M. '41), Asst. Engr., U.S. Geological Survey, 407 Federal Bldg., Helena, Mont.

Stetson, Carl Leo, Jr. (Jun. '40), Junior Topographic Engr., U.S. Geological Survey, Box 346, Sacramento, Calif.

Stevens, Elmer Bradford (Assoc. M. '40), Structural Engr., Office Engr. Div., The Panama Canal, Balboa Heights, Canal Zone.

Stevens, William Ronald (Assoc. M. '40), Cont. Engr., Bethlehem Steel Co., 1300 Telephone Bldg., St. Louis (Res., 202 Papin Ave., Webster Groves), Mo.

Stowe, Richard Henry (Jun. '40), Chf. Eng. Party, Wise Cont. Co., Yorktown (Res., 43 Cedar Ave., Newport News), Va.

Stuesstall, Kenneth Sylvan (Jun. '40), Junior Engr., Civ. Aeronautics Authority, Boeing Field (Res., 7349 Dibble Ave.), Seattle, Wash.

Sutherland, Henry Clay (Jun. '40), Detailer, Am. Bridge Co. (Res., 438 Park Rd.), Ambridge, Pa.

Thompson, Maurice Pardon (Jun. '40), Junior Engr., U.S. Army Engrs., Federal Bldg. (Res., Y.M.C.A.), Louisville, Ky.

Thompson, Sterlin Nyles (Jun. '40), Instrumentman, Freese & Nichols, 1133 Jeanette, Abilene (Res., 108 North 9th St., Temple), Tex.

Tuemmler, Frederick William (Assoc. M. '40), Staff Member, Div. of Master Plan, Dept. of City Planning, Room 2700 Municipal Bldg., New York, N.Y.

Turner, Mortimer Murrah, Jr. (Jun. '40), Junior Engr. (Civ.), U.S. Engr. Office, 10 East 17th St. (Res., 3424 West Coleman Rd.), Kansas City, Mo.

Valles, William Cecil (Jun. '40), Asst. Eng. Draftsman, U.S. Geological Survey, Arlington Medical Center (Res., 1719 North Monroe St.), Arlington, Va.

Van Tuyl, Donald Wells (Jun. '40), Care, Civ. Eng. Dept., Univ. of New Hampshire, Durham, N.H.

Ward, James Benjamin (Jun. '40), Geologist, TVA, Fort Loudoun Dam, Lenoir City, Tenn.

Wasdell, Raymond Vincent (Jun. '40), With Eng. Dept., Bethlehem Steel Co., 315 Locust St. (Res., 1064 Franklin St.), Johnstown, Pa.

Weber, Harold Everett (Jun. '41), Junior Eng. Aid, State Div. of Highways, 2001 Van Ness Ave., San Francisco (Res., 199 Greenfield Ave., San Rafael), Calif.

Wells, Otis Orlander (Jun. '40), Senior Insp., State Highway Dept., Box 449, Athens, Tex.

Westover, Harold Raymond (Jun. '40), Sales and Constr. Engr., Socony-Vacuum Div., Standard Oil Co. of New York, 112 State St. (Res., 543 Warren St.), Albany, N.Y.

Whitson, James William (Jun. '40), Junior Office Asst., State Highway Dept., Pecos, Tex.

Winkler, John Robert (Jun. '40), Asst. Eng. Draftsman, TVA, Pound Bldg. (Res., 401 Lindsay St.), Chattanooga, Tenn.

Winterkorn, Hans Friedrich (Assoc. M. '41), Research Associate Prof., Soil Mechanics, Dept. of Civ. Eng., Univ. of Missouri (Res., 307 Frederick Apartments), Columbia, Mo.

Wood, Ralph Leonard (Jun. '40), Asst. Research Engr., Cleveland Ry., 618 Midland Bldg., Cleveland (Res., Sprague Rd., Columbia Station), Ohio.

Worsham, Leroy Wesley (Jun. '40), Eng. Aide, Maps and Surveys Div., TVA, Chattanooga, Tenn. (Res., 214 Bunch St., Corinth, Miss.)

Yoder, William Esser (Jun. '40), Asst. on Corps, P.R.R., Care, Supervisor of Track, Pennsylvania Station, Lancaster (Res., 243 White Oak St., Kutztown), Pa.

Zancai, Egisto Fred (Jun. '40), Junior Engr., Pacific Gas & Elec. Co., 245 Market St., San Francisco (Res., Jackson), Calif.

MEMBERSHIP TRANSFERS

Barrows, Wilbur Raymond (Jun. '31; Assoc. M. '40), Associate Structural Engr., TVA, Knoxville (Res., 115 Rose Ave., Fountain City), Tenn.

Brooks, Harold Phillips (Jun. '30; Assoc. M. '40), Asst. Engr., Water Resources Branch, U.S. Geological Survey, 305 Federal Bldg. (Res., 1721 Belvoir Court), Topeka, Kans.

Browne, Floyd Gilmore (Assoc. M. '26; M. '40), Cons. Engr., Floyd G. Browne & Associates, 196 South Main St., Marion, Ohio.

Browne, Frederick Lee (Jun. '32; Assoc. M. '40), Junior Engr., U.S. Engr. Dept., Pier 2 A (Res., 2002-H Hunnewell St.), Honolulu, Hawaii.

Coburn, William Turley (Assoc. M. '23; M. '41), Utility Officer, Veterans Administration, Veterans Administrative Facility, Danville, Ill.

Friedlaender, Hermann (Jun. '35; Assoc. M. '40), 1958 North Normandie Ave., Hollywood, Calif.

Hall, Norman Henry (Jun. '33; Assoc. M. '40), Asst. Engr., State Conservation Comm., 10th and Mulberry Sts. (Res., 1416 Alpha Ave.), Des Moines, Iowa.

Johns, Edward Allan (Jun. '30; Assoc. M. '40), Asst. Civ. Engr., The Panama Canal, Diablo Heights, Canal Zone.

Kaminsky, Morris Moses (Jun. '26; Assoc. M. '28; M. '41), Cons. Engr., 849 Wentworth Ave., Calumet City, Ill.

Kampmeier, Roland August (Jun. '32; Assoc. M. '41), Associate Prof., Hydr. Eng., Ferris Hall, Univ. of Tennessee, Knoxville, Tenn.

Koomos, George Louis (Jun. '36; Assoc. M. '41), Junior Engr., U.S. Engr. Office, Vicksburg, Miss.

Mortimer, Winfield Stout (Jun. '36; Assoc. M. '41), Head Office Draftsman, State Dept. of Highways, North 2820 Mayfair St. (Res., 1322 South Hawthorne Pl.), Spokane, Wash.

Morton, Charles Morehead (Jun. '33; Assoc. M. '41), Constr. Engr. and Estimator, J. M. Odom, 301 Fannin St., Austin, Tex.

Tchernowitz, Jack Kalman (Jun. '35; Assoc. M. '40), Asst. Engr., Madigan-Hyland, 28-04 Forty-First Ave., Long Island City (Res., 376 Saratoga Ave., Brooklyn), N.Y.

REINSTATEMENTS

Adams, Frank, M., reinstated Jan. 28, 1941.

Burgwin, William Harold, Assoc. M., reinstated Feb. 3, 1941.

Goodhart, Morris, Jun., reinstated Jan. 14, 1941.

Gordon, Richard Thomas, Assoc. M., reinstated Jan. 10, 1941.

Guerdrum, George Hagbart, M., reinstated Feb. 7, 1941.

Kahn, Emanuel Linde, Jun., reinstated Jan. 30, 1941.

Kammer, Joseph Ivan, Assoc. M., reinstated Jan. 24, 1941.

Kilian, Theodore Philip, M., reinstated Jan. 17, 1941.

Leba, Theodore, Jr., Jun., reinstated Jan. 31, 1941.

Lesh, Harry William, Assoc. M., reinstated Jan. 28, 1941.

Mendelsohn, Isador William, M., reinstated Jan. 21, 1941.

Mullan, Albert Charles, Jun., reinstated Jan. 14, 1941.

Orr, James Lawrence, M., reinstated Jan. 27, 1941.

Pennartz, Richard Hubert, Assoc M., reinstated Jan. 10, 1941.

Pidcock, George Edwin, Assoc. M., reinstated Jan. 31, 1941.

Simon, Fred Lester, Assoc. M., reinstated Feb. 4, 1941.

Vestal, William Baxter, Assoc. M., reinstated Feb. 7, 1941.

Simonds, Fred Washburn, M., reinstated Jan. 23, 1941.

RESIGNATIONS

Harris, Albert Bullen, Jun., resigned Jan. 28, 1941.

Hodges, Richard McKandlish, M., resigned Jan. 28, 1941.

Hodges, Thomas Arthur Assoc. M., resigned Jan. 24, 1941.

Jarvi, Albert Otto, Jun., resigned Jan. 28, 1941.

Jervis, Charles Miller, M., resigned Dec. 31, 1941.

Ostoia, Vladimir Krzywiec, M., resigned Jan. 31, 1941.

Roland, John Wilson, Assoc. M., resigned Jan. 28, 1941.

Schlax, William Francis, Jun., resigned Jan. 28, 1941.

Search, Charles Oscar, Jun., resigned Jan. 28, 1941.

Stepath, Myron Davis, Jun., resigned Jan. 28, 1941.

Thorne, Marion Francis, Jun., resigned Jan. 9, 1941.

Williford, Carl Lex, M., resigned Feb. 3, 1941.

Wohlsen, Herman Frederick, Jun., resigned Jan. 28, 1941.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

March 1, 1941 **Number 3**

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

Atkin, Bernard, Springfield, Ill. (Age 45) (Claims RCM 10.9) Sept. 1921 to date with Illinois Div. of Highways as Jun. Highway Engr., Asst. Highway Engr., Asst. Dist. Constr. Engr., and (since Jan. 1935) Gen. Inspector of Constr.

Benas, Benjamin (Assoc. M.), San Francisco, Calif. (Age 42) (Claims RCA 5.4 RCM 10.2) May 1933 to date with City of San Francisco, Bureau of Eng., as San. Eng. Designer, and (since March 1939) Supt. Sewage Treatment Plant.

Bullock, William Edward, New York City. (Age 52) (Claims RCA 2.0 RCM 21.0) 1939 to date Jun. Engr., Dept. of Sanitation, New York City Dept. of Public Works; previously Senior Engr., CWA (WPA).

Cooper, Andrew Jackson (Assoc. M.), Atlanta, Ga. (Age 39) (Claims RCA 3.0 RCM 10.4) Sept. 1924 to date with Robert & Co., Inc., as Structural Draftsman, and Mgr. for various Depts., at present Mgr. of new branch established to design Supply Depot for U.S. Army.

Feinson, Samuel Henry, Brooklyn, N.Y. (Age 41) (Claims RCA 5.4 RCM 10.1) April 1925 to May 1934 and Sept. 1937 to date with Bureau of Highways and Sewers, Office of Pres. of Borough of Brooklyn; in the interim in legal practice, including some engineering.

Gottlieb, Leon (Assoc. M.), Montgomery, Ala. (Age 38) (Claims RCA 5.7 RCM 10.2) July 1922 to date with Alabama Highway Dept., as Draftsman, Inspector, Transitman, Asst. Res. Engr., Res. Engr., Asst. Div. Engr., and (since Oct. 1934) Chf. Bituminous Engr.

Graves, Hershel Douglas, Portland, Ore. (Age 42) (Claims RCA 4.2 RCM 7.5) June 1939 to date Associate Highway Bridge Engr., PRA; previously Asst. Highway Bridge Engr., U.S. Bureau of Public Roads.

Green, Arthur Edward, Albany, N.Y. (Age 50) (Claims RCM 14.8) July 1925 to date with New York State Engr.'s Office as Asst. Engr., Senior Asst. Engr., and Prin. Bridge Office Engr.

Hettman, Frederick Jacob, Salta F.C.C.N.A. Argentine Republic. (Age 56) (Claims RCA 14.7 RCM 10.3) Feb. 1933 to date Engr. in charge of mining development and production for Nueva Cia Minera Incahuasi (gold) and Cia Boratera Tincalayu (borax).

Hill, Edgar Goodspeed, New York City. (Age 57) (Claims RCA 6.6 RCM 19.5) Sept. 1920 to date with Ford, Bacon & Davis, Inc., Engrs., as Senior Engr., Vice-Pres., and Director; since 1931 also Pres., Ford, Bacon & Davis Constr. Corporation (subsidiary).

Howell, Harold Irving, Buffalo, N.Y. (Age 39) (Claims RCA 3.9 RCM 11.1) Sept. 1929 to date (except Aug. to Nov. 1934) with Niagara Hudson Power Corporation as Design Engr. and (since Oct. 1936) Asst. to Vice-Pres. and Chf. Engr.

Kester, Frederick Henry, Detroit Mich. (Age 55) (Claims RCA 5.3RCM 18.5) May 1927 to date with The Canadian Bridge Co., Ltd., Walkerville, Ont., as Vice-Pres. and (since March 1937) Gen. Mgr.

Klock, Morgan Becker, Pittsford, N.Y. (Age 48) (Claims RCA 6.0 RCM 15.4) Oct. 1919 to date with Eastman Kodak Co., Rochester, N.Y., on various work, since Dec. 1935 in responsible charge of structural engineering at Kodak Park.

Maerker, Erwin (Assoc. M.), Mt. Lebanon, Pa. (Age 56) (Claims RC 12.0 D 11.0) 1940 to date with Aluminum Co. of America; 1938 to 1940 Staff Engr., Harza Eng. Co.; previously Senior Engr. and Tech. Adviser to Prin. Engr., TVA.

Martin, Harrison Augustus, Winston-Salem, N.C. (Age 47) (Claims RCM 15.6) Dec. 1937 to date Engr., Murray & Flood, Inc., Winston-Salem, N.C., and New York City; previously Div. Manager, West Coast Power Co.

Messer, Richard (Assoc. M.), Richmond, Va. (Age 59) (Claims RCA 3.0 RCM 28.7) May 1910 to May 1918 State San. Engr., and April 1919 to date Director, Bureau of San. Eng., Virginia State Dept. of Health.

Miller, Edwin Charles, Detroit, Mich. (Age 41) (Claims RC 14.6 D 3.6) March 1937 to date Vice-Pres. and Engr., Drainage Contrs., Inc.; previously with Greeley and Hansen, Cons. Engrs., Chicago, Ill., and Blanck & Gargaro Co., Gen. Contrs., Detroit, Mich.

Mosher, Sidney Wood (Assoc. M.), St. Albans, N.Y. (Age 49) (Claims RCA 7.3 RCM 10.7) June 1923 to date with Municipal Civil Service Comm., as Civ. Engr. Member of Examining Board, Senior Engr. Examiner, and (since Jan. 1938) Engr. Examiner-in-Charge.

Mousson, Jean Marcus, 2d, Baltimore, Md. (Age 37) (Claims RCA 3.7 RCM 7.6) June 1928 to Feb. 1929 Hydr. Designer, Nov. 1929–April 1931 Asst. Engr., Pennsylvania Water & Power Co., May 1931–June 1933 Sponsor Engr., Pennsylvania Water & Power Co. and Safe Harbor Water Power Corporation and July 1933 to date Hydr. Engr., Safe Harbor Water Power Corporation.

Muckleroy, Alexander David, Nacogdoches, Tex. (Age 41) (Claims RC 8.5 D 5.1) Jan. 1938 to date in private practice in Nacogdoches; June 1937 to Jan. 1938 with City of Talco, Tex., on plans, specifications, and supervising construction of reinforced concrete paving, etc.; previously Instrumentman and Office Engr., Texas Highway Dept.

Nagle, John Leo (Assoc. M.), Washington, D.C. (Age 53) (Claims RCA 7.0 RCM 20.4) June 1918 to Aug. 1919 2d Lieut., Engrs., Aug. 1919 to July 1922 Civ. Engr., War Dept., Office, Chf. of Engrs., and Nov. 1940 to date Head Engr., Eastern Div., Corps of Engrs., U.S. Army; in the interim Designing Engr., Arlington Memorial Bridge Comm., and Chf., Constr. Sec., and Supt. of Jefferson National Expansion Memorial, National Park Service.

Perrilliat, Claiborne, New Orleans, La. (Age 37) (Claims RCA 4.0 RCM 11.5) Aug. 1933 to date Secy.-Treas. and Field Supt., Perrilliat-Rickey Constr. Co., Inc.

Smith, Brice Reynolds, Glendale, Mo. (Age 39) (Claims RCA 3.8 RCM 8.4) Sept. 1932 to date with Sverdrup & Parcel, Cons. Engrs., St. Louis, Mo., as Designer and (since Jan. 1934) Office Engr.

Smith, Frederik Egid (Assoc. M.), Houston, Tex. (Age 55) (Claims RCA 9.1 RCM 15.0) Jan. 1926 to Nov. 1927 and July 1937 to date with City of Houston, until No. 1927 with Eng. Dept. as Designing Engr., and since July 1937 with Dept. of Public Works and Dept. of Public Service as Coordinator and Expeditor of PWA and WPA projects; in the interim Res. Engr. Inspector, PWA, and Cons. Engr. at Huntington, W.VA., and Houston, Tex.

Smith, Nathan Lewis, Baltimore, Md. (Age 53) (Claims RCA 1.5 RCM 20.7) 1935 to date with State Roads Comm. of Maryland, Director of Public Works and Chairman, Chf. Engr., and (since 1939) Cons. Engr., retained in general consulting capacity by Comm. and others.

Spencer, William Benjamin, Baltimore, Md. (Age 48) (Claims RCA 5.0 RCM 19.4) Feb. 1928 to date Chf. Estimator, Consolidated Eng. Co., in charge of Estimating Dept.

Steinmetz, George Philip, Madison, Wis. (Age 44) (Claims RC 15.5 D 3.7) Sept. 1933 to date with Public Service Comm. of Wisconsin, as Chf. Eng. Auditor and (since Nov. 1935) Chf. Engr.; Jan. 1925 to date with Engr. Reserves, U.S. Army, at present as Major.

Stewart, Lowell O. (Assoc. M.), Ames Iowa. (Age 45) (Claims RC 19.4 D 7.8) Sept. 1924 to date at Iowa State Coll. as Instructor, Asst. Prof. and Associate Prof. of Civ. Eng., etc., and (since 1938) Prof. and Head of Dept. of Civ. Eng.

Taylor, Ellis Wing, Los Angeles, Calif. (Age 53) (Claims RCM 28.0) 1912 to 1925 Structural Engr., and 1925 to date Partner, Edward Cray Taylor and Ellis Wing Taylor, Archts. and Engrs.

Winfrey, Robley (Assoc. M.), Ames, Iowa. (Age 41) (Claims RCA 8.4 RCM 8.2) Jan. 1939 to date Research Associate Prof. of Civ. Eng. (highways and valuation), Iowa State Coll.; previously Special Agt. (Field Mgr.), U.S. Bureau of Public Roads.

APPLYING FOR ASSOCIATE MEMBER

Aicher, John Barron, Easton, Pa. (Age 31) (Claims RCA 3.6) June 1940 to date Asst. Civ. Engr., Trojan Powder Co., Allentown, Pa.; previously Asst. Res. Engr., Gannett, Eastman and Fleming, Inc., Engrs., Harrisburg, Pa.; with WPA on work for Borough of Wilson.

Aug, George Christian Oesterle, Binghamton, N.Y. (Age 45) (Claims RCA 2.6 RCM 2.0) Jan. 1935 to date with U.S. Engr. Office, as Inspector and (since Aug. 1938) Associate Engr. and Engr.

Baer, Carl Toevs, Dallas, Tex. (Age 48) (Claims RCA 10.1 RCM 9.4) Dec. 1928 to date with City of Dallas as Asst. Drainage Engr.,

Engr. of Drainage, Senior Engr., and Senior Engr. of Designs; since Dec. 1940 on leave of absence for government work as Engr. at Camp Wolters, Tex.

Bohner, Theodore Vincent, Fargo, N.Dak. (Age 35) (Claims RCA 9.9) Sept. 1940 to date Instructor in Civ. Eng., North Dakota Agricultural Coll.; previously Asst. Testing Engr., Highway Testing Dept., Univ. of Nebraska, Lincoln, Nebr.

Butler, Earle Bennett (Junior), Knoxville, Tenn. (Age 28) (Claims RCA 2.0) June 1935 to date with TVA, as Under Engr. Aide, Asst. Engr. Aide, Eng. Aide, Jun. Engr., and (since Jan. 1939) Asst. Engr., Chf. Engr.'s staff; at present 1st Lieut., Corps of Engrs., Officers Reserve Corps.

Campbell, Thomas Herbert, Jr. (Junior), College, Alaska. (Age 28) (Claims RCA 1.5) Sept. 1934 to May 1937 and Sept. 1938 to May 1939 Instructor in, and Sept. 1939 to date Asst. Prof. of, Civ. Eng., Univ. of Alaska; in the interim graduate student.

Carberry, Deane Edwin (Junior), Denver, Colo. (Age 30) (Claims RCA 3.5 RCM 1.0) July 1931 to date with U.S. Bureau of Reclamation as Jun. Engr., Asst. Engr., and (since Sept. 1939) Associate Engr.

Cochran, Albert Ludwell (Junior), Silver Spring, Md. (Age 32) (Claims RCA 1.9 RCM 1.8) Feb. to May 1939 Asst. Engr., and May 1939 to date Associate Engr., Eng. Sec., Board of Rivers and Harbors, Office of Chf. of Engrs., War Dept., Washington, D.C.; previously Computer, Jun. Engr., and Asst. Engr., U.S. Engr. Office.

Cohen, Benjamin Carl (Junior), Long Island City, N.Y. (Age 31) (Claims RCA 3.0) Jan. 1936 to May 1937 Structural Draftsman, and Oct. 1938 to date Engr., Madigan-Hyland; in the interim Structural Engr., M. W. Kellogg Co., New York City.

Cravens, James Wade (Junior), Paris, Tex. (Age 30) (Claims RCA 2.7) Nov. 1935 to date with Texas Highway Dept., as Plant Inspector, Asst. Res. Engr., Dist. Office Engr., and (since June 1939) Jun. Res. Engr.

Date, Richard Foster, Cordova, Alaska. (Age 27) (Claims RCA 1.9) Dec. 1939 to date Practicing Engr., Date & Swalling, Contrs.; previously with Capt. A. E. Lathrop, Bldr., Anchorage, Alaska; graduate student and Student Instructor, Univ. of Washington, Seattle; Instructor in Civ. Eng. and Mathematics, Univ. of Alaska.

Davidson, Clifford Arthur, Washington, D.C. (Age 37) (Claims RCA 3.9) July 1939 to date Associate Hydr. Engr., Div. of Power-Flood Control Surveys, Federal Power Comm.; previously with U.S. Forest Service as Surveyor, Asst. Civ. Engr., and Associate Civ. Engr.

Dunaway, Paul Harrison, New Laguna, N.Mex. (Age 34) (Claims RCA 6.7) Aug. 1933 to date with U.S. Indian Service as Trail Locator, ECW, and (since May 1934) Project Manager, CCC-ID, United Pueblos Agency, Albuquerque, N.Mex.

Eagle, Henry Carlson (Junior), Helena, Mont. (Age 32) (Claims RCA 3.3) Feb. 1934 to date with Water Resources Branch, U.S. Geological Survey as Hydrographer, Jun. Engr., and (since Feb. 1939) Asst. Engr.

Fregosi, Albert (Junior), Bayside, N.Y. (Age 32) (Claims RCA 5.9 RCM 0.4) Oct. 1940 to date Capt., Engr. Reserves, Constr. Div., Fixed Fee Branch, Office of Quartermaster General, Washington, D.C.; previously with New York Telephone Co., as Engr., Engr.-Instructor, and Installer.

Grady, James Arthur (Junior), Morgantown, W.Va. (Age 32) (Claims RCA 1.2 RCM 5.6) June 1934 to date with E. I. du Pont de Nemours & Co., as Area Engr., Asst. Constr. Supt., Constr. Supt., Asst. Engr. and Engr. in charge of construction.

Greaser, Maylin Henry, Philadelphia, Pa. (Age 32) (Claims RCA 5.9) June 1930 to date with U.S. Engr. Office as Inspector, Jun. and Asst. Engr. (Civil), and (since Jan. 1937) Asst. Engr. and Associate Engr. (Civil).

Hayes, Harry, Los Angeles, Calif. (Age 44) (Claims RCA 6.0) Aug. 1929 to date Topographic Draftsman, Eng. Div., Bureau of Water-Works and Supply, Dept. of Water and Power, City of Los Angeles.

Kintler, Frank Cyprian, Cincinnati, Ohio. (Age 33) (Claims RCA 3.7 RCM 0.3) Feb. 1937 to date with U.S. Engr. Office, as Surveyman, Jun. Engr., and (since Oct. 1939) Asst. Engr.; previously Draftsman, Instrumentman, and Asst. Engr., Ohio Dept. of Highways.

Kopkowski, Ignatius Michael, Hamtramck, Mich. (Age 34) (Claims RCA 6.8) July 1936 to July 1937 and Aug. 1938 to Jan. 1939 Asst. City Engr., and Jan. 1939 to date City Engr.; previously with Michigan State Highway Dept., Lansing, Mich.

Lee, Lester Dale, Milwaukee, Wis. (Age 38) (Claims RCA 10.7 RCM 4.2) July 1927 to March 1935 and Jan. 1937 to date Asst. Map Draftsman, City Engr.'s Dept.; in the interim Field Supervisor, Dept. of Public Works.

Legault, Adrian Raymond, Ft. Collins, Colo. (Age 31) (Claims RCA 2.4) Jan. 1936 to Sept. 1938 and Sept. 1939 to date with Colo. State Coll., as Instructor and Testing Engr., and Asst. Prof. and Testing Engr.

Lind, Ralph Edward, New Orleans, La. (Age 45) (Claims RCA 10.0) Oct. 1940 to date Prin. Asst. Engr., Barnard, Godat & Heft, Cons. Engrs.; previously Engr. Thomson Machinery Co., Inc., Labadieville, La.; Structural and Design Engr., Union Station project, New Orleans; with Bridge Dept., Louisiana Highway Comm.

Marsh, Malcolm Ray, Las Cruces, N.Mex. (Age 40) (Claims RCA 2.6 RCM 0.7) Nov. 1935 to date with SCS as Jun. Agri. Engr., etc., and (since Nov. 1940) Asst. Agri. Engr.

Maynard, Frederick Alexander, San Jose, Calif. (Age 37) (Claims RC 4.0 D 2.3) Aug. 1940 to date with SCS, U.S. Department of Agriculture; Jan. 1938 to May 1940 student and graduate student, Univ. of Nevada; previously Project Engr., U.S. SCS.

Messer, Roy Thomas (Junior), Ames, Iowa. (Age 32) (Claims RCA 5.2 RCM 5.0) March 1930 to date with Iowa Highway Comm., in various capacities, and (since Sept. 1938) Asst. Traffic Engr.

Miles, Henry James, Gainesville, Fla. (Age 33) (Claims RCA 3.7) Sept. 1939 to date Asst. Prof. of Civ. Eng., Univ. of Florida; previously Instructor at Southern Methodist Univ., Dallas, Tex., and South Dakota State Coll., Brookings, S.Dak.; Special Investigator, Textile Foundation, Washington, D.C.

Niotis, Demetrios John, Chicago, Ill. (Age 38) (Claims RCA 7.9) March 1937 to May 1938 Res. Engr., Bureau of Streets, and July 1938 to date Draftsman and Designer, Water-Works Design Div., Chicago; previously Jun. Engr., Illinois Highway Dept., Chicago.

Nixon, Daniel Decatur (Junior), Brownwood, Tex. (Age 31) (Claims RCA 7.0 RCM 0.4) Oct. 1940 to date Senior Engr., Koch & Fowler; previously Office Engr. with Nueces County (Tex.) Engr., and Rodman, Inspector, Instrumentman, and Jun. Res. Engr., Texas Highway Dept.

Oglesby, Clarkson Hill (Junior), Phoenix, Ariz. (Age 32) (Claims RCA 4.8) June 1928 to Sept. 1930, Sept. 1932 to Sept. 1934, June to Sept. 1935, and Dec. 1937 to date with Arizona State Highway Dept., as Computer, Field Draftsman, Office man, Transitman, Inspector, Designer, and (since Aug. 1940) Project Engr.

Parker, Albert Denny, Berkeley, Calif. (Age 32) (Claims RCA 3.4) July 1940 to date Engr., Bldg. Dept., City of Berkeley, Calif.; previously Engr., Standard Oil Co. of California.

Perry, Clifton Benoit (Junior), Mt. Kisco, N.Y. (Age 38) (Claims RCA 4.7) March 1940 to date Eng.-Inspector, New York City Board of Water Supply; previously with Madigan-Hyland, New York City as Instrumentman-Inspector, Concrete Inspector, Chf. of Party and Inspector.

Prather, James Carter, Atlanta, Ga. (Age 35) (Claims RCA 5.4) Oct. 1935 to date with F. H. Neely, Rich's, Inc., Atlanta, as Asst. Bldg. Supt., and (since Feb. 1937) Bldg. Supt. and Cons. Engr.

Salvadori, Mario George, New York City. (Age 33) (Claims RCA 5.3) 1940 to date Lecturer in Civ. Eng., Columbia Univ.; 1939 Time and Motion Study Engr., The Lionel Corporation, Irvington, N.J.; previously First Asst. and (later) Instructor and Asst. Prof., Univ. of Rome.

Smith, Walter Lane (Junior), Memphis, Tenn. (Age 32) (Claims RCA 7.2) Jan. 1934 to date Pres. and Gen. Mgr. of Operations, Memphis (Tenn.) Stone & Gravel Co.

Spath, Paul Christian (Junior) Chattanooga, Tenn. (Age 32) (Claims RCA 5.7 RCM 1.0) May 1935 to date with TVA as Eng. Aide, Jun. Hydr. Engr., and (since Jan. 1939) Asst. Hydr. Engr.

Spaulding, George Whittier, Baltimore, Md. (Age 41) (Claims RCA 7.0 RCM 5.1) Jan. 1938 to date Asst. Chf. Engr., Pennsylvania Water & Power Co., and Safe Harbor Water Power Corporation; previously Test Engr., Asst. Chf. of Tests, and Asst. to Gen. Supt., Pennsylvania Water & Power Co.

Stanley, Arthur Emmons, Muscatine, Iowa. (Age 32) (Claims RCA 2.0 RCM 1.7) Jan. 1934 to July 1939 with Young & Stanley, Inc., and July 1939 to date member of firm, Stanley Eng. Co.

Stoller, Mandell Dudley (Junior), Tampa, Fla. (Age 32) (Claims RCA 1.7) May 1935 to Nov. 1936 and March 1940 to date with U.S. Army as 2d Lieut. and 1st Lieut.; since Aug. 1940 with 28th Engrs. (Aviation), MacDill Field; in the interim with City of New York as Draftsman, Dept. of Sanitation, and Eng. Asst., Dept. of Public Works; with Fischbach & Moore, Inc., New York City, as Asst. to Engr., and Head of Cost Distribution Dept.

Weiss, Burrage, El Centro, Calif. (Age 37) (Claims RCA 6.4 RCM 2.5) May 1929–Sept. 1933 and March 1939 to date with Imperial (Calif.) Irrigation Dist., as Draftsman-Designer, Design Engr., Res. Engr., and (since Aug. 1940) Asst. Field and Drainage Engr.; in the interim Asst. Bridge Constr. Engr., and Asst. Bridge Engr., San Francisco–Oakland Bay Bridge, California State Dept. of Public Works, Oakland, Calif.

Welden, Richard Wayne (Junior), Iowa Falls, Iowa. (Age 32) (Claims RCA 7.7) June 1931 to June 1933 Constr. Supt. and Office Engr., and Sept. 1933 to date Estimator and Supt., Welden Bros., Contrs.

Wells, Heber (Junior), Malden, Mass. (Age 32) (Claims RCA 5.0) April 1937 to date Estimator, Waghorne-Brown Co., Boston, Mass.; previously Engr., Harvard Univ. Maintenance Dept.

West, Carleton Taylor, Glendale, Calif. (Age 41) (Claims RCA 2.5 RCM 12.0) 1928 to date Engr. and (later) Purchasing Agt., Monolith Portland Cement Co., Los Angeles.

White, Henry Martyn, Macon, Ga. (Age 39) (Claims RCA 11.1 RCM 0.2) Jan. 1939 to date Chf. Engr., W. N. Brown, Inc., Washington, D.C.; previously Surveyor as White Surveying & Mapping Co., Orlando, Fla.; Surveyman and Surveyor, U.S. Army Engrs.

Wood, Benson Jarvis (Junior), Detroit, Mich. (Age 32) (Claims RCA 3.6 RCM 2.5) Jan. 1941 to date Structural Engr., Smith, Hinchman & Grylls, Inc.; previously Bridge Designing Engr. II, Michigan State Highway Dept.; Structural Engr. with Michigan Consolidated Gas Co., and Shoecraft, Drury and McNamee; Office Engr., Semet Solvay Eng. Corporation; Senior Civ. Eng. Draftsman, Dept. of Public Works, City of Detroit.

APPLYING FOR JUNIOR

Brown, Wallace Merton, Los Angeles, Calif. (Age 30) (Claims RC 2.0 D 1.3) Nov. 1935 to date with U.S. Engr. Office, as Jun. Eng. Aide, Eng. Aide, Jun. Engr., and (since Oct. 1939) Asst. Engr.

Carpenter, Dana Herbert, Ada, Okla. (Age 25) (Claims RCA 1.2) Jan. 1940 to date associated with George L. Poynter, as City Engrs. for Pauls Valley, Ada, Allen and Seminole, Okla.; previously Sub-Inspector (Core-Boring), U.S. Engr. Dept.; Rodman and Apprentice Engr., Phillips Petroleum Co.

Cook, Milton Ford, Lebanon, Tenn. (Age 27) June 1937 to date Jun. Engr., U.S. Geological Survey, Chattanooga, Tenn.; previously Eng. Aide, U.S. Engr. Office, Vicksburg, Miss.; Under Eng. Aide, TVA, Chattanooga.

Donley, Russell Lee, Laramie, Wyo. (Age 30) (Claims RCA 1.0 RCM 0.9) Sept. 1939 to date Instructor in Civ. Eng., Univ. of Wyoming; previously with City of Los Angeles, Calif., Greybull Valley Irrigation Dist., Emblem, Wyo., and Howard F. Bell, Engr., Cody, Wyo.

Erickson, Herbert Bernard, Culbertson, Mont. (Age 23) 1939 B.S., Mont. State Coll.; Nov. 1939 to date Jun. Agri. Engr., SCS, U.S. Dept. of Agriculture, Billings, Mont.; previously Trail Locator for U.S. Indian Service CCC-ID, Browning, Mont.

Glace, Ivan Maxwell, Jr., Harrisburg, Pa. (Age 27) (Claims RCA 0.8) Oct. 1940 to date Asst. Engr., J. N. Pease & Co., Engrs. and Archts., Charlotte, N.C.; previously Field Engr. with T. M. Flanaghan, Contrs., Reading, Pa.; Asst. Engr., I. M. Glace & Associates, Harrisburg and Waynesboro, Pa.

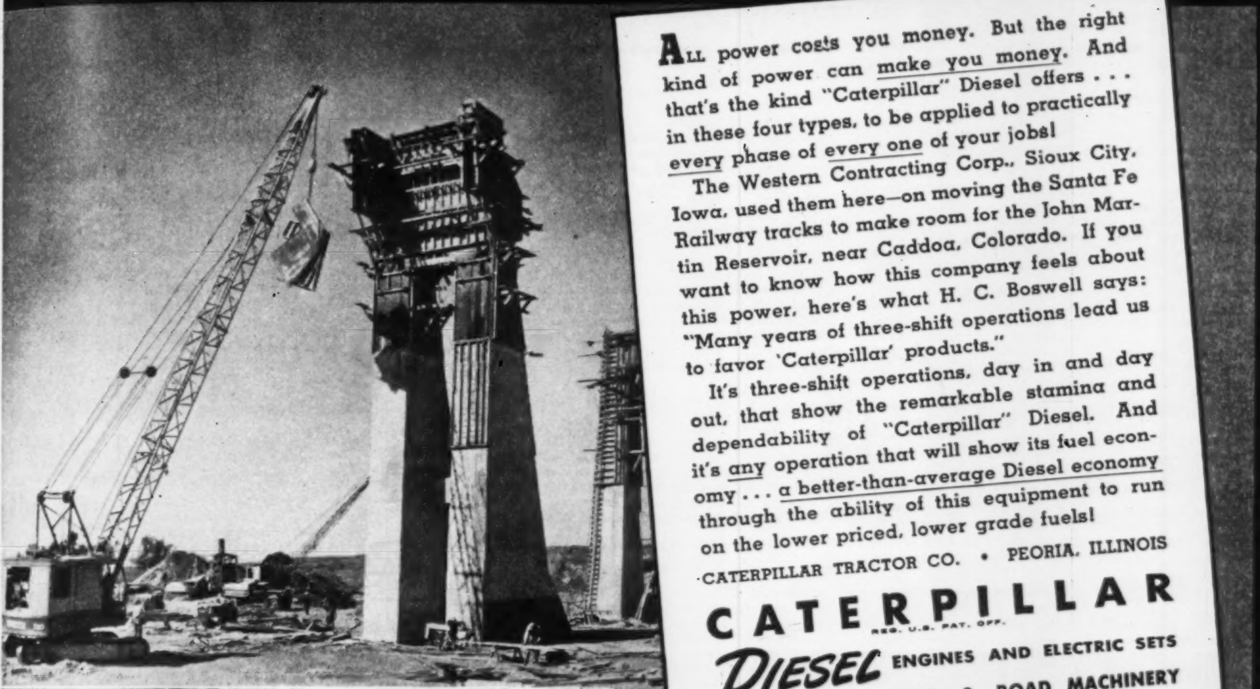
Levy, Stanley Edwin, Watts Bar Dam, Tenn. (Age 31) Dec. 1934 to date with TVA as Jun. Eng. Draftsman, Eng. Draftsman, Jun. Structural Engr., and (since Oct. 1939) Jun. Engr. (Structural).

Maley, William Teahen, Jr., New York City. (Age 27) (Claims RCA 2.0) June to Dec. 1937, April to Sept. 1938 and Nov. 1938 to date with Waddell and Hardesty, Cons. Engrs., since June 1940 Draftsman and Detailer on Rainbow Bridge, Niagara Falls, N.Y.

Mathis, Philip Jack, Montgomery, Ala. (Age 23) 1939 B.S.C.E., Univ. of Ky.; Nov. 1939 to date Jun. Hydr. Engr., Water Resources Branch, U.S. Geological Survey.

Matthias, Carl Douglas, Norfolk, Va. (Age 26) July 1936 to March 1939 Inspector (Dredging), March to Sept. 1939 Eng. Aide (Civil), and Sept. 1939 to date Jun. Engr. (Civil), U.S. Engr. Dept.

A "4-LANE HIGHWAY" to Profit!



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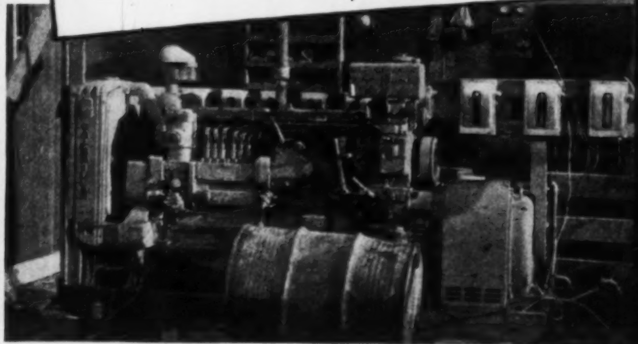

(Upper) STATIONARY POWER! A "Caterpillar" Diesel D13000 Engine powers this Koehring dragline with a 90-foot boom. Shown setting forms for railroad bridges. (Lower) MORE STATIONARY POWER! A "Caterpillar" Diesel D4600 Engine powering a Dayton Dowd 3-stage centrifugal pump. 4-inch main . . . 19,000 gallons an hour . . . pumped as far as 5 miles to wet material on the fill.

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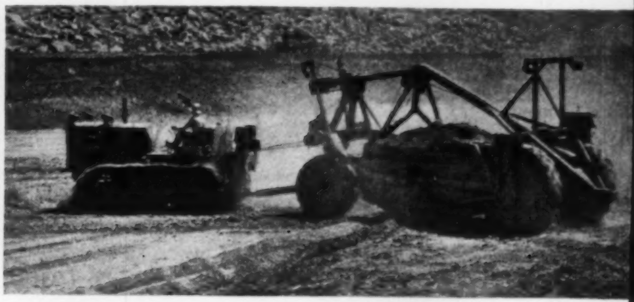

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ONNECTING the pipe and assembling the joints is an easy, fast and foolproof

Mayo, Ronald Ira, San Francisco, Calif. (Age 25) Aug. 1940 to date Jun. Engr., Water Resources Branch, U.S. Geological Survey; previously Eng. Aide, Federal Power Comm.; Graduate Research Asst., Eng. Experiment Station, Joint Highway Research Project, Purdue Univ.; Student Technician, CCC.

Nagel, Robert Hamilton, Knoxville, Tenn. (Age 22) (Claims RCA 0.4) 1939 C.E., Cornell Univ.; Aug. 1939 to date with TVA, as Jun. Eng. Aide, Asst. Eng. Aide, and (since Oct. 1940) Jun. Office Engr.

Nicholson, Richard Walter, Chicago, Ill. (Age 29) (Claims RCA 1.2 RCM 3.1) Aug. 1935 to date with Consoer, Townsend & Quinlan, Cons. Engrs., as Office Engr., Constr. Inspector and Res. Engr.

Post, Ezriel, New York City. (Age 24) 1937 S.B., and 1938 S.M., Mass. Inst. Tech.; May 1939 to date with Silberblatt & Lasker, Inc., since May 1940 Asst. Supt. of Constr. for N.Y. State School Mental Defectives, Bldg. No. 2, Willowbrook, N.Y.

Pratt, Harold Kenneth, Kirkwood, Mo. (Age 30) (Claims RCA 1.0) Oct. 1934 to date with U.S. Engr. Office, as Asst. Inspector, Inspector, and (since April 1938) Eng. Aide, Jun. Engr., and Asst. Engr., Civ. Eng. Sec., Upper Mississippi Valley Div., St. Louis, Mo.

Ramotowski (Ramond), Theodore Stanley, Chicago, Ill. (Age 25) (Claims D 0.4) Dec. 1940 to date Designer and Draftsman, Natural Gas Pipeline Co. of America; previously with Calumet Steel Co., Div. of Borg Warner Corporation, Wendnagel & Co., U.S. Engr. Office, and Illinois State Highway Comm.

Steinborn, Sydney Oswald, Balboa, Canal Zone. (Age 26) Sept. 1938 to date with The Panama Canal, Special Eng. Div., Diablo Heights, C.Z., as Student Engr., and (since April 1940) Jun. Civ. Engr., Hydr. Sec.

Stone, John August, Lincoln, Nebr. (Age 31) (Claims RCA 1.5), March 1935 to date with Bridge Dept., State of Nebraska as Draftsman, Bridge Draftsman, Bridge Detailer and (since Aug. 1940) Jun. Bridge Designer.

Treloar, Richard William, Providence, R.I. (Age 23) Nov. 1940 to date Eng. Asst., Southern New England Telephone Co., New London, Conn.; previously with M. A. Gammino Constr. Co., Charles A. Maguire & Associates, Rowley Constr. Co., and Raymond Concrete Pile Co.

Wolfsheimer, Frank, Washington, D.C. (Age 25) (Claims RCA 2.0) June 1935 to date Supt. and Estimator, Hechinger Eng. Corporation.

1940 GRADUATES

UNIV. OF CALIF.
(B.S. in Civ. Eng.)

	Age
Hutchison, Lawrence Joseph	(22)
Knowlton, Charles Franklin	(24)
Oberman, Gilbert	(21)
Olson, Walter Earl	(23)
Parlett, Robert Frederick	(21)
Pirtz, David	(23)
Rau, Norman Frederick	(21)
Replogle, Allen Daniel	(22)
Schultz, Samuel	(22)
Teixeira, Stanley Edwin	(22)

MASS. INST. TECH.
(S.M.)

Warner, Wallace Payson (Also 1939 S.B.)	(23)
Zeevaert Wiechers, Leonard (Also 1939 C.E., Univ. of Mexico)	(26)

(S.B.)

Sussman, William (Also 1938 B.A., Columbia Univ.)	(22)

MICH. COLL. OF MIN. & TECH.
(B.S. in C.E.)

Ingersoll, Wayland Delmar	(21)

UNIV. OF N.DAK.
(B.S. in Civ. Eng.)

Norling, Leonard Telstad	(23)

PA. STATE COLL.
(B.S. in Civ. Eng.)

Shira, William Spence	(23)

PRINCETON UNIV.
(B.S. in C.E.)

Mead, Lawrence Myers, Jr.	(22)

UNIV. OF WASH.
(B.S. in Civ. Eng.)

Holm, Carl	(22)
Wright, Otis Alner	(27)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

Items are furnished by the Engineering Societies Personnel Service, 31 West 39th Street, New York, N.Y. Address replies to key number, care of New York Office, unless Chicago, Detroit, or San Francisco office is designated. See page 132 of Society's 1940 Year Book for details of procedure.

CONSTRUCTION

Civil Engineer; Assoc. M. Am. Soc. C.E.; age 33; 10 years varied experience in real estate development, industrial construction and maintenance, and general construction in field, drafting room, and office; desires position as office engineer or field contact man on new construction, planning, layout, or erection. Location in the East preferred. C-816.

Graduate Civil Engineer; M. Am. Soc. C.E.; mechanical and electrical training, also; experienced as engineer and contractor, in subways, sub-aqueous tunnels, railroad, bridges, municipal work, concrete pipe manufacture, and as head of shipyard. Building construction for the past 17 years in New Jersey and New York. Available now. C-819.

DESIGN

Civil Engineer; Assoc. M. Am. Soc. C.E.; age 46; graduate; New York license; over 20 years in structural design and construction; 14 years in design and layout of mercantile, office, and power buildings; 4 years as field engineer; 5 years as contractor's engineer and estimator. Now employed; available after March 10. C-817.

JUNIOR

Civil Engineer; Jun. Am. Soc. C.E.; 26; married; B.S.C.E., New York University, 1934; working on master's degree; 6 years varied experience in topographic surveying, flood control, hydraulics, hydrology, and construction Now employed; desires evening and week-end employment in estimating, surveying, tutoring, or kindred subjects. Location, New York City. C-815.

RESEARCH

Civil Engineer; Assoc. M. Am. Soc C.E.; California license; desires position covering research, planning, statistics, reports on development and economic utilization of land, etc.; writer, speaker, and public relations expert; exceptional experience. Available now; location immaterial. C-818.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

(The) Design of High Pressure Plant and the Properties of Fluids at High Pressures. By D. M. Newitt. Clarendon Press, Oxford, England; Oxford University Press, New York, 1940. 491 pp., illus., diagrs., charts, tables, 10 × 6 in., cloth, $10.

The first part of this book is devoted to the kinds and properties of materials used in the construction of high-pressure plant and equipment, the calculation of the stresses and strain that must be dealt with, practical design data, and the measurement of high pressures. In Part II the pressure-volume-temperature relationships of gases and liquids, the equation of state problem, and the influence of pressure upon such properties as viscosity, solubility, and refractivity are discussed.

Exploration Geophysics. By J. J. Jakosky. Times-Mirror Press, Los Angeles, Calif., 1940. 786 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $8.

The chief object of this book is to describe the fundamental theories, equipment, and field techniques of the recognized exploratory geophysical methods, and to illustrate their application to problems of economic geology. An early chapter presents the geologic and economic background, and succeeding chapters deal respectively with magnetic, gravitational, electrical, seismic, geochemical, and geothermal methods. Drill-hole investigations and oil-well production problems are also considered. In addition to literature references in the text there is a patent bibliography appended to each chapter.

Geophysical Exploration. By C. A. Heiland. Prentice-Hall, New York, 1940. 1013 pp., illus., diagrs., charts, tables, $9^1/_2$ × 6 in., cloth, $10.

This book is intended as a comprehensive survey of the entire field of geophysical exploration, emphasizing the relations, differences, common features, and fundamentals of geophysical methods. The elementary first part describes working principles and geological applications for those not directly concerned with field or laboratory operations. The second and major part discusses the subject from an engineering viewpoint, presenting theory, field technique, laboratory procedure, and geological interpretations for gravitational, magnetic, seismic, and electrical methods. Consideration is also given to minor methods and to geophysical well-testing.

Graphs, How to Make and Use Them, rev. ed. By A. Arkin and R. R. Colton. Harper & Brothers, New York and London, 1940. 236 pp., illus., diagrs., charts, tables, $9^1/_2$ × 6 in., cloth, $3.

All the usual methods of graphic representation are clearly and simply explained in this introductory work on the subject. The opening chapters present general principles and proper equipment for graph construction, and a wide variety of uses in business, economics, engineering, and other fields is illustrated in the succeeding chapters.

Hoisting Machinery. By W. H. Atherton. Technical Press, London, 1940. 314 pp., illus., diagrs., charts, tables, 10 × 6 in., cloth, 32s. 6d.

This practical volume deals with the design, construction, maintenance, and uses of the types of material-handling equipment which perform intermittent short-range movements: cranes, derricks, grabs, skip hoists, stackers, telphers, and transporters. There are many helpful illustrations, and literature references appear both in the text and in a brief bibliography at the end.

Locomotives on Parade. By E. Hungerford. Thomas Y. Crowell Co., New York, 1940. 236 pp., illus., woodcuts, diagrs., charts, 9 × $6^1/_2$ in., cloth, $2.50.

The history of one of the very important mechanical contributions of the last century—the steam locomotive—is told in layman's language. The sucessive types that evolved are described, including famous individual representatives and the men whose insight and mechanical genius made them possible. There are many photographs and line drawings.

Modern Road Emulsions, 2 ed. By F. H. Garner, L. G. Gabriel, and H. J. Prentice. Road Emulsion and Cold Bituminous Roads Association Ltd., 11 Bow Church Yard, London, E.C. 4, 1939. 245 pp., illus., diagrs., charts, tables, 9 × $5^1/_2$ in., cloth, 10s.

The purpose of this book is to present the underlying principles and properties of bituminous emulsions and their behavior on the road. Some historical material, methods, and plant for the transport and application of emulsions, and many tests and specifications are also included. There is a bibliography.

Port Dictionary of Technical Terms. Compiled by Committee on Standardization and Special Research. American Association of Port Authorities, 2223 Short St., New Orleans, La., 1940. 208 pp., $9^1/_2$ × 6 in., cloth, $1.50.

An enlargement of an earlier glossary, this technical dictionary defines words and phrases pertinent to all phases of port and harbor work. Many of the several hundred definitions are of considerable length, where special explanation was thought necessary.

Practical Tunnel Driving. By H. W. Richardson and R. S. Mayo. McGraw-Hill Book Co., New York and London, 1941. 436 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $5.

This practical text and reference book for engineers and contractors covers all phases of tunneling and all kinds and classes of tunnels. All steps, from the engineering fundamentals to completion of the project, are considered, including full discussion of location, investigation, and planning of the project, design, construction, and economics. Attention is paid to such practical details as track layout, size of cars, timbering, explosives, etc., and there is a brief history of tunneling.

Venezuela. By Henry J. Allen. Doubleday, Doran and Co., Inc., New York, 1940. 299 pp., illus., maps, 9 × 6 in., cloth, $3.

Useful as a travel book, this complete and authoritative volume is also valuable as a key to the history and politics of one of the most interesting and colorful countries of South America.

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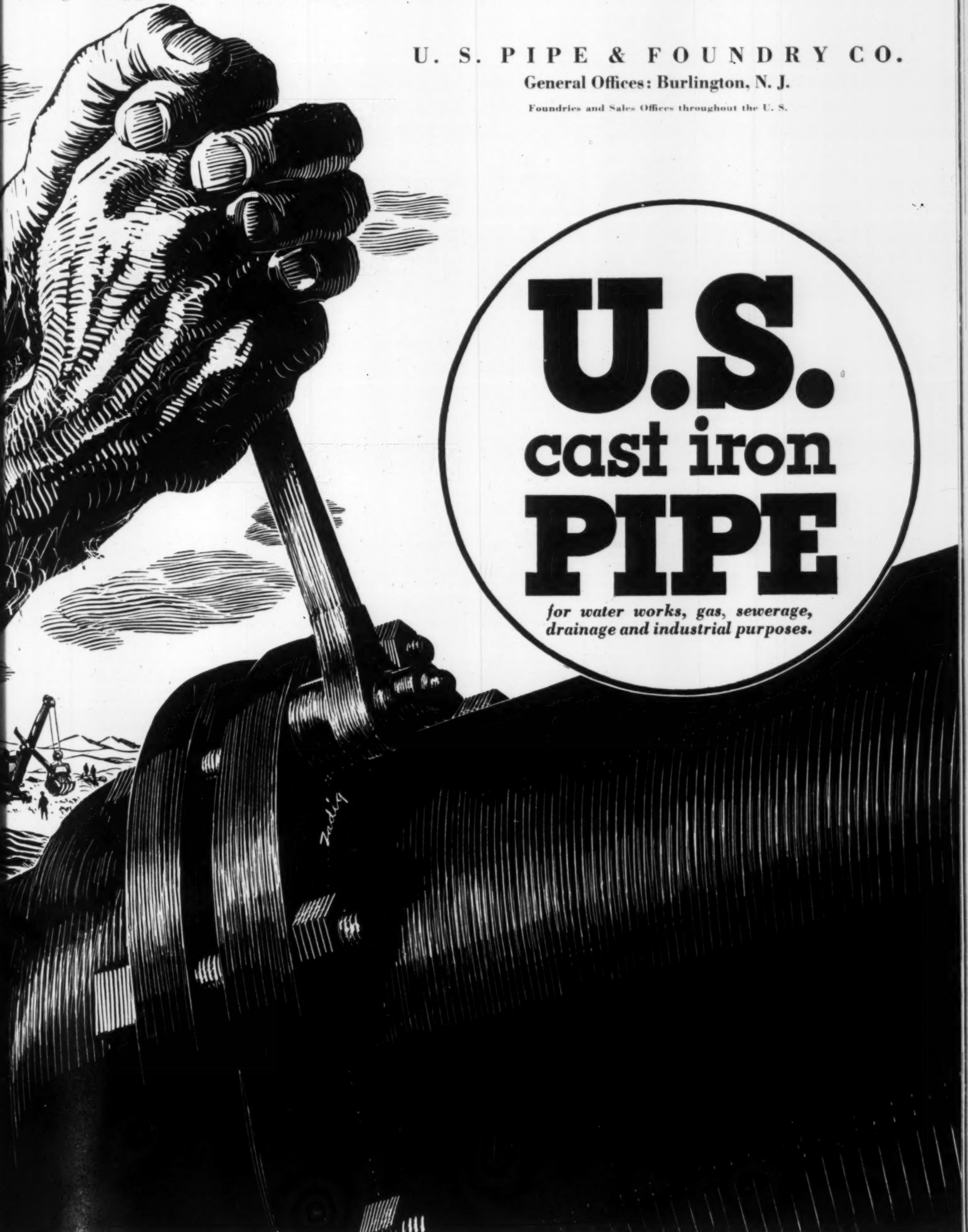

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and Foreign Lands

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page to members of the Founder Societies (30 cents to all others), plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Bearings. Zur Beruecksichtigung der Reibungskraefte in Brueckenauflagerungen, H. Perl. *Schweizerische Bauzeitung*, vol. 116, no. 17, Oct. 26, 1940, pp. 189–190. Theoretical mathematical analysis of frictional stresses in bearings of bridge girders.

Construction, Superstitions. Bridge Builders' Superstitions, R. A. Stephenson *Roads & Streets*, vol. 83, no. 12, Dec. 1940, p. 47. Ancient and modern superstitions connected with bridge construction.

Highway, Approaches. Field Problems and Construction Methods, C. C. Arnold. *Pac. Bldr. & Engr.*, vol. 46, no. 44, Nov. 1940, pp. 28–32. Report on construction of approaches to Lake Washington floating bridge at Seattle, Wash., which involved clearing, grading, draining, and surfacing of four miles of four-lane modern highways and several miles of new or relocated side and approach roads; construction of nine grade-separation structures, four major bridges, and Mt. Baker twin-bore tunnel.

Plate Girder, Pittsburgh, Pa. Welded Girder Bridge Set in Five Hours, F. R. Smith. *Ry. Eng. & Maintenance*, vol. 36, no. 8, Aug. 1940, pp. 500–503. Description of effective replacement of grade-separation structure on Union Railroad, near Pittsburgh, Pa.; 1,704 lb. of welding rods used; company forces fabricated new structure, made up largely of wide flange beams, in shop, transported it to site of erection on gondola car, and set it in place with crane, replacing old skew, plate-girder, grade-separation span.

Pontoon, Seattle, Wash. Pontoon Highway Bridge Has Novel Movable Span, R. M. Murray. *Roads & Streets*, vol. 83, no. 12, Dec. 1940, pp. 42–45. Description of Lake Washington floating bridge, with special reference to draw pontoon 59 ft wide, 378 ft long; operating mechanism of draw pontoon.

Railroad, Spain. La del puente sobre el Cadagua, del ferrocarril de Bilbao a Portugalete, F. Wais. *Ferrocarriles y Tranvias*, vol. 7, no. 69, May 1940, pp. 144–149. Cadagua River bridge, on railroad from Bilbao to Portugalete; description of repair work on steel truss bridge, destroyed in June 1937 by dynamiting of abutments.

Railroad, Strengthening. Stronger Bridges—Larger Locomotives, J. F. Marsh. *Ry. Age*, vol. 109, no. 26, Dec. 28, 1940, pp. 977–979 and 982. Description of 7-year bridge-strengthening program begun by Rock Island Railroad in 1936, involving more than 600 bridges and 3,400 miles of line.

Railroad, Switzerland. Die Brueckenbauten der neuen Lorrainelinie der SBB in Bern, A. Buehler. *Schweizerische Bauzeitung*, vol. 116, nos. 8, 9, 10, 11, and 14, Aug. 24, 1940, pp. 83–88; Aug. 31, pp. 95–100; Sept. 7, pp. 107–111; Sept. 14, pp. 124–125; and Oct. 5, p. 156. Design and construction of several types of steel and concrete bridges on new Lorraine electric railroad line at railroad station of Bern, Switzerland, including reinforced concrete arch span 150 m long.

Steel Truss, Baton Rouge, La. Twin Cantilevers Erected by Balancing, E. L. Durkee and L. F. Kirkley. *Eng. News-Rec.*, vol. 126, Jan. 2, 1941, pp. 12–15. Methods and equipment used in erection without use of falsework bents, of combined steel truss bridge across Mississippi River at Baton Rouge, La., consisting of 5 spans 490 ft to 848 ft in length; special precautions taken; stages in balanced cantilever erection scheme.

Steel Truss, Raising. Bridge of Gods Jacked Up 44 Feet, H. W. Young. *Contractors & Engrs. Monthly*, vol. 37, no. 9, Sept. 1940, pp. 1 and 21, and figs. on p. 48. Methods and equipment used in raising steel cantilever highway bridge, 1,127 ft long, 44 ft further above level of Columbia River upstream of Bonneville Dam.

Suspension, Failure. Did Rhythmic Gusts of Wind Destroy Tacoma Narrows Suspension Bridge? H. P. Gillette. *Roads & Streets*, vol. 83, no. 12, Dec. 1940, pp. 38–39. Discussion of possible cause of failure of Tacoma Narrows suspension bridge, suggesting that bridge was swung back and forth by rhythmic gusts of wind harmonic with bridge's pendulistic period, until it was wrecked.

Wood Preservation. Alton and Southern Treats Lumber and Timber with Wolman Salts. *Ry. Eng. & Maintenance*, vol. 36, no. 8, Aug. 1940, pp. 513–515. Wolman salts preservative treatment for lumber, timber, and piles in large merchandise dock, coaling plant, and foot bridge, and also for bridge and track ties, to prevent decay and termite attack; in each case cited, history of treatment employed is presented and salt retention used is specified.

BUILDINGS

Airways, Terminals. Airlines' Terminal in New York City. *Aero Digest*, vol. 37, no. 6, Dec. 1940, p. 40–41. Airlines Terminal Building in New York City is 6-story limestone building of modern, classic architecture; lighting of main waiting ticket area achieved by use of 32 recessed lights reflecting downward; air conditioning system provides constant temperatures for entire area of public waiting room and ticket booths; escalators installed for passenger use and elevators for handling of limousines; offices on upper floors.

Office Buildings, Accident Prevention. Built with Safety. *Safety Eng.*, vol. 80, no. 2, Aug. 1940, pp. 9–10. Safety measures employed in construction of 7-story building for Aetna Life Affiliated Companies, New York; notes on foundation problem; safeguarding public; safety measures in evidence during this project are mentioned; experienced supervision.

Office Buildings, Bomb Shelters. St. Helens Corporaton Transport. *Passenger Transport J.*, vol. 83, no. 2105, Nov. 8, 1940, pp. 171–173; see also *Transport World*, vol. 88, no. 2827, Nov. 14, 1940, pp. 193–196. New modern offices for St. Helens Corporation Transport Department described; building has two stories and basement; full advantage taken of latter to give occupants of building at any time adequate protection from missiles dropped by enemy aircraft; large part of basement utilized for A.R.P. shelter; roof is heavily strengthened; elevator installed leading to basement.

CITY AND REGIONAL PLANNING

Integration. Integration of Regional Plan, A. C. Comey. *Planners' J.*, vol. 6, no. 2, Apr.-June 1940, pp. 29–32. General discussion of planning based on dominant activity; integration of physical regional plan; sequence in integrated physical plan.

CONCRETE

Aggregates, Standards. Concrete and Concrete Aggregates. *Am. Soc. Testing Matls.—Standards* (1940 Supp.), pt. II, 1940, pp. 84–87 and 264–269. Specifications for concrete aggregates; methods of testing efficiency of materials for curing concrete and volume change of cement of mortar and concrete.

Design. Simplification of Design Diagrams, J. D. W. Ball. *Concrete & Constr. Eng.*, vol. 35, no. 10, Oct. 1940, pp. 479–483. Construction of diagram linking up proportion of reinforecement, position of neutral axis, ratio of tensile stress in steel to compression stress in concrete, and section modulus for compression and for tensile stress.

Mixing. Designing Concrete Mixtures for Pavements, W. F. Kellermann. *Crushed Stone J.*, vol. 15, no. 5, Nov.-Dec. 1940, pp. 7–14 and 18. Method of investigating flexural strength of concrete in connection with problem of designing concrete mixtures for pavements; results of series of laboratory tests which demonstrate how flexural strength may vary over wide range due to characteristics of aggregates employed.

Mixing, Temperature Control. Temperature Control of Concrete Mixing Water in Imperial Valley, J. R. Lawrence. *Reclamation Era*, vol. 30, no. 10, Oct. 1940, pp. 288–289. Use of portable cooling tower for pre-cooling of concrete-mixing water at Imperial Valley, Calif., construction sites, where pipe-line water may reach temperature of 133 F.

Reinforcement, Glass. Glass Strip as Reinforcement for Concrete, W. I. Marshall. *Civ. Eng.* (London), vol. 35, no. 412, Oct. 1940, pp. 294–295. Report on further experimental studies on use of glass strip as substitute for steel for reinforcing concrete with view to increasing spans possible; use of "lapping"; factor of safety.

DAMS

Debris Control, California. Single-Arch Dams for Debris Control, P. Burch. *Min. J.* (Phoenix, Ariz.), vol. 24, no. 15, Dec. 30, 1940, pp. 2–3. Supplementing paper indexed in *Engineering Index* 1939, p. 557, author gives further data on progress in building of dams to permit resumption of hydraulic mining in California; Upper Narrows dam, on Yuba River, near Marysville, to be completed in 1941; development of single-arch type of dam; debris dams are all overflow structures with no separate spillway structure provided.

Hydraulic Fill, Montana. Topping Out Fort Peck Dam, H. V. Pehrson. *Pac. Bldr. & Engr.*, vol. 46, no. 44, Nov. 1940, pp. 33–35. Construction of rolled-fill topping at Fort Peck Dam, in Montana, which involved moving 1,300,000 cu yd of pervious material and placement of impervious core and pervious material; list of major equipment used; construction of stone facing.

Reservoirs, Columns. Pre-Cast Supports and Girders Carry 4-Acre Reservoir Roof. *Eng. News-Rec.*, vol. 126, no. 1, Jan. 2, 1941, pp. 20–21. Use of pre-cast concrete columns, girders, and beams for supporting corrugated metal roof over 4-acre, filtered water reservoir at Ventura, Calif.; concrete specifications; erecting columns; beams and purlins; details at column tops; roof ventilation.

Spillways, Construction. Outside Rods Hold Semi-Circular Concrete Form Without Interior Ties. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, p. 489. Description of concrete forms for construction of high, slender piers of spillway section of Guntersville Dam on Tennessee River; form for semicircular pier nose was designed to be held with rods circling exterior of form.

Spillways. Floating-Ring Gate and Glory-Hole Spillway at Owyhee Dam, L. G. Smith. *Reclamation Era*, vol. 30, no. 8, Aug. 1940, pp. 226–231. Description of glory-hole type spillway at Owyhee Dam in Oregon, noted for its unprecedented height of 309 ft, with 60-ft crest diameter, having 12-ft overflow height controlled with steel-ring gates; gate controls; performance.

FLOOD CONTROL

Colorado. Cherry Creek Flood Control, J. E. Field. *Engrs.' Bul.*, vol. 24, no. 11, Nov. 1940, pp. 6–7. Data on unprecedented rainfall and floods on Kiowa, Bijou, and Monument Creeks, areas adjacent to Cherry Creek region, Colorado; determination of average precipitation given in table; absorptive quality of ground.

Switzerland. Das Hochwasser im Gebiete des Bachtels vom 25 August 1939, O. Brockmann. *Wasser- u. Energiewirtschaft*, vol. 32, nos. 2, 3, and 4, Feb.-Mar. 1940, pp. 13–18, and Apr. pp. 33–36. Study of unusual cloudbursts of August 25, 1939, which affected about 30 sq km near Zurich, Switzerland, resulting in runoffs as high as 17 cu m per sec per sq km for watershed of 2 sq km, and 7.6 cu m per sec per sq km for drainage area of 25 sq km; description of damage caused by floods.

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Cavitation. Flow Phenomena in Hydraulic Butterfly Valves Subjected to Cavitation, H.

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Bleuler. *Engrs. Digest*, vol. 1, no. 2, July 1940, pp. 81–84. Aerodynamic test method as employed by Escher Wyss forms basis for design of new butterfly valves patented by firm; purpose of special kind of tests dealt with was investigation of butterfly valves operating under conditions involving cavitation in which case limits are set to application of aerodynamic method. From *Escher Wyss Nachrichten*, vol. 12, nos. 1-2.

Underground Water. Étude de quelques écoulements souterrains, E. Feylessoufi. *Bul. Technique de la Suisse Romande*, vol. 66, nos. 18 and 20, Sept. 21, 1940, pp. 197–201, and Oct. 5, pp. 209–214. Results of theoretical and experimental studies of flow of water in soils across sheet piling cutoff walls, including case of apron adjoining cutoff wall.

FOUNDATIONS

Buildings. Underpinning Buildings. Underpinning Beats Subway Threat to Famous Chicago Building. *Eng. News-Rec.*, vol. 125, no. 13, Sept. 26, 1940, pp. 422–426. Construction of caissons for underpinning of floating foundations of old 17-story Monadnock office building in Chicago in close proximity of new Dearborn St. subway; shoring of brick piers; picking up combination piers; caisson sinking.

Petroleum Refineries, Northwest Territories. Modern Refinery Built Close to Arctic Circle. *Eng. & Contract. Rec.*, vol. 53, no. 22, May 29, 1940, pp. 10–11. Discussion of modern method adopted to prevent heaving of ground frozen to depth of 50 ft for foundation of stabilizing plant at Norman Wells, Northwest Territories, Canada, having daily capacity of 840 bbl of crude oil; grading of foundation site.

Piers, Construction. Wharf at Newcastle (N.S.W.). *Concrete & Constr. Eng.*, vol. 35, no. 10, Oct. 1940, pp. 487–492. Description of new 300-ft extension of existing timber wharf at Newcastle, New South Wales; 47-ft width of monolithic beam-and-slab construction, which is supported on transverse rows of bearing piles spaced at 6-ft 6-in. centers; details of piles; use of vibrated slag concrete; pile formwork and casting; pile driving.

Pontoon, Seattle, Wash. Floating Bridge More Stable Than Fixed Spans, L. R. Durkee. *Pac. Bldr. & Engr.*, vol. 46, no. 31, Aug. 3, 1940, pp. 38–41. Design and construction of system of anchors and anchor cables of Lake Washington pontoon bridge of Seattle, Wash.

Retaining Walls, Construction. Umbau der grossen Stuetzmauer im Bahnhof Bern, W. J. Heller. *Schweizerische Bauzeitung*, vol. 116, no. 14, Oct. 5, 1940, pp. 156–158. Reconstruction of old masonry retaining wall of 15-m maximum height at railroad station of Bern, Switzerland.

Testing. Successful Experience with Rod Sounding for Bridge Foundations, J. C. Merrell. *Eng. News-Rec.*, vol. 126, no. 1, Jan. 2, 1941, p. 33. Experience of Ohio State Department of Highways with drive-rod sounding at foundation sites for highway bridges, for predicting pile lengths and bearing values, and for proportioning spread footings; sound costs.

HYDRAULIC ENGINEERING

Flow of Water, Open Channels. Fluessigkeitsbewegung in der Naehe einer geknickten Flussohle, K. Otsubo. *Hokkaido Imperial Univ. Faculty Eng.-Memoirs*, vol. 6, no. 1, May 1940, 97 pp. Report on original experimental laboratory study of flow of water in vicinity of drop in stream bed, including hydraulic jump phenomena. (In German.)

Hydraulic Laboratories, Australia. Modern Hydraulic Laboratory. *Commonwealth Engr.*, vol. 28, no. 2, Sept. 2, 1940, pp. 47–50. Description of new hydraulic laboratory of Thompsons Engineering and Pipe Company at Castlemaine, Victoria, Australia, designed principally for testing and checking of centrifugal pumps, injectors, valves, etc.

HYDROLOGY AND METEOROLOGY

Earthquakes, Peru. El subsuelo de Lima observado a traves del ultimo terremoto, V. C. Alcedan. *Sociedad de Ingenieros del Peru—Informaciones y Memorias*, vol. 41, no. 5, May 1940, pp. 183–189. Subsoil of Lima observed during the last earthquake; review of earthquakes suffered at Lima, Peru, from year 1586 to May 24, 1940; doubt is expressed as to possibility of predicting earthquakes; suggestions as to precautions advisable in building construction.

HYDROLOGY AND METEOROLOGY

Rain and Rainfall, Periodicity. Forecasting by Means of Climatic Cycles, H. P. Gillette. *Water Works & Sewerage*, vol. 87, no. 10, Oct. 1940, pp. 496–501. Method of forecasting climatic cycles on basis of analysis of varve and tree-ring records; indication of regular rainfall cycles of 22.2-year duration; relation between sunspot cycles and climatic cyles; method of detecting cyclic tendencies in rainfall and other climatic records; effect of solar physics on terrestrial climate.

Rain and Rainfall, Periodicity. Prospective Dry Years, H. P. Gillette. *Pan-American Geologist*, vol. 74, no. 3, Oct. 1940, pp. 165–178, supp. plate. Review of author's studies of periodicity of rainfall as indicated by varves and tree-rings, leading to prediction of continuing series of droughts until about 1990.

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Soils, Erosion. La erosion de los suelos, M. Quinteros, E. T. Arocena and D. R. Vercesi. *Revista de Ingenieria*, vol. 34, no. 8, Aug. 1940, pp. 237–259. Erosion of soils; text of report of subcommittee to Commission for Revision of Agricultural Laws; general considerations; formation of vegetal soil; destruction of vegetal soil; conservation methods; detailed study of farms and preparation of detailed crop rotation and other working plans, as practiced in the United States.

Wave Mechanics. Recent Experimentation on Wave Action, A. C. Lieber, Jr. *Shore & Beach*, vol. 8, no. 3, July 1940, pp. 85–91 and 94–95. Report before American Shore and Beach Preservation Association on field and laboratory studies of water wave mechanics; wind velocity and wave height; stereophotographic studies; wave action and sand movement; deep water and shallow water waves; verifying Rayleigh and Stokes equations; model studies of works; wave action against seawalls; research in Great Britain; water depth and wave break; Stucky and Bonnard investigation.

IRRIGATION

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Canals, Australia. Excavators Applied to Irrigation Mulwala Canal Works, N.S.W. *Commonwealth Engr.*, vol. 28, no. 1, Aug. 1, 1940, pp. 30–33. Use of dragline and other excavating machinery in construction of 75 miles of Mulwala irrigation canal in New South Wales, having capacity of 2,500 cu ft per sec; maintenance of plant and repairs; use of dragline buckets for trimming; trimming of side slopes; cost of maintenance, repairs and renewals in relation to output; excavation construction costs.

Idaho. History of Irrigation in Idaho's Snake River Valley, E. R. Harrington. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 346–369. Review of development of irrigation in Snake River Valley, Idaho, since 1880, with special reference to solution of problems resulting from peculiar lava bed formation.

Mexico. Distrito de Riego de Santa Rosa, Zac. *Ingenieria* (Mexico), vol. 14, no. 12, Dec. 1, 1940, pp. 412–424. Santa Rosa irrigation district in State of Zacatecas; preliminary works begun in 1936, for reconditioning old Santa Rosa dam on Chico River, to increase storage capacity from 3.5 to 14.5 million cubic meters; general description; history; geology; soil analysis; design and construction of irrigation works; agricultural crops; cattle; fish culture; black bass protected until 1942.

LAND RECLAMATION AND DRAINAGE

Drainage Canals, Design. Graphical Method for Direct Determination of Channel Dimensions, R. B. Hickok. *Agric. Eng.*, vol. 21, no. 9, Sept. 1940, pp. 343–345. Design of drainage canals for non-uniform and periodic flows; flow in vegetated channels; design diagram for trapezoidal channel used for diversion of hillside drainage; design diagram for shallow parabolic channels such as may be employed for terrace outlets and field waterways. Before Am. Soc. Agric. Engrs.

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Tunnels, Seepage. Ground Water Seepage Into Tunnel, J. H. A. Brahtz and J. R. Bruggeman. *Mines Mag.*, vol. 30, no. 11, Nov. 1940, pp. 591–593, and 613. Theoretical mathematical discussion of application of bipolar transformation in determination of quantity of seepage water that will enter tunnel; potential theory of slow viscous flow; application to masonry dams; practical application of theory to drainage galleries and to percolation into tunnels. Bibliography.

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Road Materials. Test Track Built to Study Highway Base Materials. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 342–344. Description of circular testing track of California Division of Highways for developing basic information on relative advantages of various types of select or stabilized materials for use in low-cost road design; characteristics of materials installed in test track.

Subsoils. Soils. *Am. Soc. Testing Matls.—Standards* (1940 Supp.), pt. II, 1940, pp. 285–304. Tentative methods of surveying and sampling soils for highway subgrades; tests for moisture density relations of soil cement mixtures; freezing and thawing and wetting and drying tests of compacted soil cement mixtures.

PORTS AND MARITIME STRUCTURES

Antiquity. Ancient Harbours—I and II, L. H. Savile. *Engineer*, vol. 170, nos. 4426 and 4427, Nov. 8, 1940, pp. 300–302, and Nov. 15, pp. 316–317; see also *Engineering*, vol. 150, nos. 3905, 3906, and 3907, Nov. 15, 1940, pp. 395–396; Nov. 22, pp. 418–419; and Nov. 29, p. 438. Illustrated description of harbors of Alexandria and Tyre; Grecian and Roman harbors. Before Instn. Civ. Engrs.

Bulkheads. Something New in Bulkhead Anchorages, G. B. Sowers. *Eng. News-Rec.*, vol. 125, no. 11, Sept. 12, 1940, pp. 355–356. Design and construction of steel sheet-pile bulkheads along some sections of new channel of Cuyahoga River in Cleveland, anchored by pile A-frames where lack of space or sliding ground made ordinary deadman anchorage impracticable; back or tension leg of A-frame consists of concrete bulb pile, which developed more than 100 tons pulling resistance during test.

Construction Equipment. Appleton Dock Excavating by Dragline. *Commonwealth Engr.*, vol. 28, no. 1, Aug. 1, 1940, pp. 38 and 40. Use of dragline in excavation and dredging on construction of new Appleton Dock for Melbourne Harbor Trust Commissioners, Australia, totaling 455,000 cu yd.

New Orleans. Port of New Orleans, J. A. Airey. *Mar. News*, vol. 27, no. 7, Dec. 1940, pp. 16–19. Port conditions and facilities; transport agencies.

Shore Protection, Maryland. Preservation of Shoreline and Beaches of Maryland, S. S. Steinberg. *Baltimore Engr.*, vol. 14, no. 11, May 1940, pp. 4–8. General discussion of engineering and legal aspects of beach and shore protection, with special reference to Maryland conditions.

RAILROADS, STATIONS, AND TERMINALS

Railroad Stations, Floors. What Kind of Floor? A. L. Sparks. *Ry. Eng. & Maintenance*, vol. 36, no. 8, Aug. 1940, pp. 511–512 and 515. Author discusses various types of flooring materials available with regard to their appearance, service characteristics, and maintenance, for large and small passenger stations; materials include wood blocks, tile, and concrete.

Railroad Structures, Harbors and Rivers. Report of Committee 25—Waterways and Harbors. *Am. Ry. Eng. Assn.—Bul.*, vol. 42, no. 420, Nov. 1940, pp. 87–93. Breakwaters, bulkheads, and jetties; study of metal and other protective casings for pier structures under water; seawalls and ocean shore protection, including effect of wave action and ice; reasonable life of steel casings immersed in sea water.

ROADS AND STREETS

Asphalt. Asphalt Surfacing as Done in Texas, J. Gresham. *Earth Mover*, vol. 27, no. 11, Nov. 1940, pp. 9–11. Description of methods and equipment employed in handling asphalt surfacing in Texas; base preparation; loading, hauling, and distributing aggregates; hot-mix asphaltic concrete; asphalt stabilization.

Construction. Safety Completes a Dream. T. W. Osgood. *Safety Eng.*, vol. 80, no. 2, Aug. 1940, pp. 15–16 and 20. Measures adopted for accident prevention in construction of Pennsylvania Turnpike. Previously indexed from *Roads & Streets*, June 1940.

Design. Standardisation of Plans, Sections, etc., for Road Works, G. L. Robb. *Roads & Road Construction*, vol. 18, nos. 212, 213, and 214, Aug. 1, 1940, pp. 150–153; Sept. 2, pp. 168–171; and Oct. 1, pp. 186–188. Aug. 1: Standards for preparation and method of presenting plans, sections, and detail drawings of road reconstruction schemes; drainage plan and longitudinal section. Sept. 2: Mass haul diagram and longitudinal section; cross sections; detail drawings of junctions, bridges, and other structures. Oct. 1: Supplementary detail of drawings of horizontal curves, vertical curves, and banking.

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Guard Rails. Steel Guard-Rail Installed Along 46 Miles of Monterey Coast Road, L. H. Gibson. *Calif. Highways & Pub. Works*, vol. 18, no. 11, Nov. 1940, pp. 12–13 and 28. Description of 46-mile guard rail installation on Roosevelt Highway, between San Luis Obispo and Monterey in California, featuring rolled-edge steel railing 12 in. wide, $^5/_{32}$ in. thick.

Highway Lighting, Metal Vapor. Sodium Lights New York City Belt Parkway, N. J. Kelly. *Gen. Elec. Rev.*, vol. 43, no. 11, Nov. 1940, pp. 438–441. World's largest sodium-lighted highway installation uses 2,417 10,000-lumen sodium lamps; details of installation given.

Highway Systems, Argentina. Como se han cumplido los primeros objectivos de la vialidad argentina. *Ingenieria* (Buenos Aires), vol. 44, no. 789, July 1940, pp. 548–561 and map. How primary objectives of Argentine highway program have been fulfilled; location of national highway network; objectives attained; finance; gasoline tax; Pan-American routes; highway organization; next steps in program; future work.

Ice Control. Chemicals Assist in Ice Control on Highways. *Eng. & Contract. Rec.*, vol. 53, no. 38, Sept. 18, 1940, pp. 55–57. Discussion of methods, materials, and equipment used in ice control on highways for reducing accidents; use of cinders as an effective abrasive for prevention of skidding; use of mechanical spreading equipment.

Low Cost. Low Cost Bituminous Highways, F. S. Gilmore. *Wis. Eng. Soc.—Annual Report*, vol. 15, no. 3, July 1940, pp. 23–31. Review of low-cost bituminous road construction in Western states; types of low-cost bituminous roads and their performance; construction procedure; traveling plants; advantages of bituminous mix types of construction; reasons for improved performance.

Maintenance and Repair. Maintenance of Texas State Roads, M. B. Hodges. *Earth Mover*, vol. 27, no. 11, Nov. 1940, pp. 12–14. Organization of maintenance work by Texas State Highway Department controlling about 23,000 miles of highways; maintenance costs; maintenance of joints and repair of cracks.

Maintenance and Repair. Sub-Grade Treatment by Mud-Jacking and Filling—II, P. J. Kunzer. *Roads & Streets*, vol. 83, no. 12, Dec. 1940, pp. 50, 52, and 54. Mud-jack and auxiliary equipment; details of lifting and sealing operations; results and anticipations; progress, data, and costs. See also *Engineering Index* 1940.

Materials, Felt. Use of Subgrade Felt Produces Better Road Surface. *Eng. & Contract. Rec.*, vol. 53, no. 40, Oct. 2, 1940, pp. 9–11. Review of Canadian and United States experience with satisfactory use of felt on subgrade of highways to eliminate rough spots and prevent cracks; preparing subgrade with scratch template and light roller before placing felt; placing concrete on felt to prevent absorption of water by subgrade soil.

National Defense. Road System Falls Short of National Defense Needs. *World Petroleum*, vol. 11, no. 13, Dec. 1940, pp. 34–37. Improvement in existing federal and state highways of the United States and addition of new links necessary for rapid movement of troops and supplies; bridge replacement called for; construction of access roads to camps and munitions plants immediate task.

Railroad Crossings. Earth Moving for Grade Separation, B. R. Abery. *Commonwealth Engr.*, vol. 28, no. 4, Nov. 1, 1940, pp. 111–115. Description of plant and methods used for excavating and placing earthwork to form approaches for new overhead crossing of railway line on Hume Highway at Broadford, N.S.W.; cost figures.

Railroad Crossings, Gates. Gates, Signals and Traffic Lights at Wabash Crossing. *Ry. Signaling*, vol. 33, no. 12, Dec. 1940, pp. 693–695 and 702. Red-yellow-green stop-and-go traffic signals installed at three intersections of highways, located on Wabash tracks, between Chicago, Ill., and St. Louis, Mo.; short arm gates and reflex crossing signs and bells added to existing flashing light signals.

Soil Survey. Use of Soil Surveys in Highway Construction, W. B. Worsham. *Eng. & Contract. Rec.*, vol. 53, no. 39, Sept. 25, 1940, pp. 9–12. Utilization of soil surveys for construction of roads; taking soil profiles; time required and cost of surveys; value of highway soil surveys.

Soils, Stabilization. Estabilizacao pela drenagem, A. Ribeiro. *Sao Paulo, Brazil. Departamento de Estradas de Rodagem—Boletim*, vol. 6, no. 21, Oct. 1940, pp. 399–405. Stabilization by drainage; general commentary on problem of providing satisfactory support for unconsolidated fills and slopes, with particular reference to experiences in construction of "Via Anchieta" automobile highway in state of Sao Paulo, where elimination of excessive curves involved some heavy fills.

Soils, Consolidation. A compactacao artificial dos aterros das auto extradas: Via Anchieta e Via Anhanguera, R. Duffles Andrade. *Sao Paulo, Brazil. Departamento de Estradas de Rodagem—Boletim*, vol. 6, no. 21, Oct. 1940, pp. 406–425. Artificial compacting of earth fills on highways Via Anchieta and Via Anhanguera, in State of Sao Paulo, Brazil; fills, sometimes 15 m high; mechanics of soil constituents; compression with smooth and sheeps foot rollers; shock with light and heavy tampers; vibration, unfavorable for compacting coherent masses; procedure; test data.

Stabilization. Earth Roads. Experiments in Soil Stabilization. *Civ. Eng.* (London), vol. 35, no. 412, Oct. 1940, pp. 288–289. Review of series of researches carried out at Irrigation Research Institute, Lahore, India, into problems associated with soil stabilization, particularly from aspect of constructing low-cost roads for country districts; sand soil mixtures stabilized with molasses; effect of salts and strength of cement mortars; effect of coarseness of sand.

Stabilization. Methods of Arriving at Total Depths of Sub-base, Base and Surfacing for Ballasting Subgrade Soils for Stability, J. O. Izatt. *Roads & Streets*, vol. 83, no. 12, Dec. 1940, pp. 29–33. Review of practice of Idaho Bureau of Highways; step-by-step illustrations of how recommended depths are arrived at, using tables and laboratory test data; soils-evaluation tables; California method of surface stabilization; Arizona method of base stabilization.

Texas. Texas Highway System, E. J. Amey. *Earth Mover*, vol. 27, no. 10, Oct. 1940, pp. 5–7 and 32. Description of system as whole and of planning, finance, and other activities of Texas State Highway Department.

SANITARY ENGINEERING

Argentina. Obras Sanitarias de la Nación. *Ingenieria* (Buenos Aires), vol. 44, no. 789, July 1940, pp. 500–517. National sanitation works; summary of operations of branch of public works department of Argentina, dealing with water supply and treatment, municipal drainage, and sewage disposal.

SEWERAGE AND SEWAGE DISPOSAL

Activated Sludge. Mechanism of Activated Sludge Process—Results of Recent Investigations of Engineering Interest, C. N. Sawyer. *Wis. Eng. Soc.—Annual Report*, vol. 15, no. 3, July 1940, pp. 52–64. Summary of papers by author and associates indexed from *Sewage Works J.*, 1939 and 1940, covering following subjects: Effect of temperature upon activity of activated sludge; effect of concentration of activated sludge and of return sewage upon rate of oxygen utilization; oxygen requirements of activated sludges. Bibliography.

Disposal Plants, Blowers. Selection of Centrifugal Blowers for Sewage Works, R. T. Regester. *Baltimore Engr.*, vol. 15, no. 3, Sept. 1940, pp. 2–9. Review of blower characteristics; influence of temperature on performance; capacity selection; computation of pressure losses throughout system for entire capacity range of blowers; capacity pressure curves; power considerations.

Disposal Plants, British Columbia. Modern Sewage Treatment Plant at Vernon B.C., C. A. East. *Eng. & Contract. Rec.*, vol. 53, no. 43, Oct. 23, 1940, pp. 11–14. Description of new sewage disposal plant with capacity of about 1 mgd, serving population of 4,000, recently built at Vernon, B.C., at cost of $54,000.

Disposal Plants, Meriden, Conn. Sewage-Treatment Plant, A. J. Burdoin. *Am. City*, vol. 56, no. 1, Jan. 1941, pp. 50–52 and 77. Description of new 8-mgd sewage disposal plant of Meriden, Conn., with special reference to grit chambers and comminutors, Imhoff tanks, sludge beds, and meters; improvements to sand filters; operating results; cost of construction.

Disposal Plants, Operation. Plant Operating Results. *Sewage Works Eng. & Mun. Sanitation*, vol. 11, no. 11, Nov. 1940, pp. 564–565. Guggenheim process operation at New Britain, Conn.

Disposal Plants, Seattle, Wash. Sewage Treatment Plant for Primary Treatment Only, M. O. Sylliaasen. *Eng. & Contract Rec.*, vol. 53, no. 47, Nov. 20, 1940, pp. 10–13 and 34. Description of 8-mgd sewage disposal plant serving small portion of Seattle, Wash., designed for primary treatment only with provisions for full treatment in future; functions of control house; digestion processes; construction features.

Disposal Trends. Progress and Trends in Sewage Treatment, L. R. Howson. *Wis. Eng. Soc.—Annual Report*, vol. 15, no. 3, July 1940, pp. 32–41. Review of recent progress in sewage treatment; screening; grit removal; settling tanks; sludge digestion; sludge disposal; secondary treatment; trickling filters; activated sludge; disposal of garbage with sewage.

Dual Disposal. Design Factors for Dual Disposal, L. R. Howson. *Eng. News-Rec.*, vol 126, no. 1, Jan. 2, 1941, pp. 22–23. Discussion of design of plants for combined disposal of sewage and garbage; application of principles to design of dual 40-mgd activated sludge plant of Gary, Ind., which will also handle daily output of 30 to 35 tons of garbage.

Industrial Waste. Sewers Needn't Become Clogged, J. H. Stoutenberg. *Factory Mgmt. & Maintenance*, vol. 98, no. 11, Nov. 1940, p. 79. Notes on use of stilling basins and suitable manholes at proper places to prevent stoppage of sewers by bulky masses or accumulations of sediment.

Plants, Barrie, Ont. Barrie Sewerage Works, G. G. Reid. *Water & Sewage*, vol. 78, no. 9, Sept. 1940, pp. 7–11 and 45. Design and construction of intercepting sewer, 15 to 24 in. in diameter, about 6,000 ft long, at cost of about $65,000; construction and equipment of new sewage treatment plant and pumping station at cost of $60,000.

Plants, Chicago, Ill. World's Largest Sewage Disposal Plant Will Be Doubled in Size. *Eng. News-Rec.*, vol. 125, no. 21, Nov. 21, 1940, pp. 698–699. Outline of plan for enlargement of Southwest sewage disposal works in Chicago where activated sludge treatment will be provided for daily flow of 900 mgd; sludge disposal facilities with average capacity of 500 tons per day; provisions for by-product recovery of fertilizer as well as steam generation; stormwater flow operation.

Plants, New Haven, Conn. Sewage Treatment Wins Its "Y", C. A. Emerson. *Sewage Works Eng. & Mun. Sanitation*, vol. 11, no. 10, Oct. 1940, pp. 483–491. Description of new sewage disposal plant of New Haven, Conn., costing $1,200,000; sludge disposal facilities; sludge conditioning; sludge filtration; sludge incinerator; Meadow Street intercepting sewer; main sewage pumps; comminutors; grit chambers; chlorinators; settling tanks; sludge digestion, gas control and utilization; gas holder and compressors; equipment inventory.

Plants, Springfield, Mass. New Sewage-Treatment Plants for Springfield, Mass, A. A. Burger. *Am. City*, vol. 55, no. 10, Oct. 1940, pp. 43–46. Description of Bondi's Island sewage disposal plant of Springfield, Mass., having present capacity of 30 mgd; gas collection; elutriation; sludge filters and incinerator; contract bids totaling $2,307,000.

Sewage Tanks. Septic Tanks, D. N. Ganguli. *Assn. Engrs.—J.*, vol. 16, no. 2, June 1, 1940, pp. 35–53. Review of principles of design of septic tanks for disposal of sewage from private houses; features of 11 design types.

Sewers, Construction. Constructing Sewer in Tunnel, H. M. Stanley. *Pub. Works*, vol. 7, no. 9, Sept. 1940, p. 15. Construction of tunnel at Clifton Forge, Va., 4.5 ft by 5.5 ft high and about, 1,600 ft long, for laying new sewer main.

Sewers, Construction. Sewer Construction Methods in South Australia, C. E. Bayer. *Commonwealth Engr.*, vol. 28, no. 2, Sept. 2, 1940, pp. 64–67. Report on present-day construction methods adopted on section of Tapley's Hill Road trunk sewer at Hendon in Port Adelaide drainage area, and on sections of trunk sewers along Grand Junction Road and along Lower Main North Road, near Dry Creek in Adelaide drainage area; sewers are of vitrified clay up to 24 in. in diameter; cost data.

STRUCTURAL ENGINEERING

Anti-Aircraft Protection, Shelters. Large or Small A.R.P. Shelters. *Engineer*, vol. 170, no. 4427, Nov. 15, 1940, p. 314. Editorial discussion of recommendations of A.R.P. Coordinating Committee, independent body which has doctors, architects, scientists, and engineers, on its membership; committee advocates construction of large and really bombproof shelters of tunnel or "deep"-shelter type or built on surface; shelters should be of large size.

Beams, Concrete. Rapid Design of Beams, N. A. Dews. *Concrete & Constr. Eng.*, vol. 35, no. 1, Jan. 1940, pp. 21–35. Presentation of design formulas and charts for flanged and rectangular beams in bending; numerical examples.

Beams, Tubular. Spun Tubular Beams, P. Abeles. *Concrete & Constr. Eng.*, vol. 35, no. 5, May 1940, pp. 233–240. Report on tests for determination of properties of spun tubular beams, extent to which tensile reinforcement can be exploited, and possible saving of reinforcement; loading capacity of spun beams compared with other test results; tests on beams without reinforcement.

Brick Construction. Rational Design of Load-Bearing Brickwork. *Civ. Eng.* (London), vol. 35, no. 411, Sept. 1940, pp. 264–266. Graphical charts and tables for design of brickwork walls and columns in accordance with British ordinances; numerical examples.

Chimneys, Design. Relation of Chimney to Smoke Abatement Problem, J. G. Mingle. *Power Plant Eng.*, vol. 44, no. 12, Dec. 1940, pp. 66–67. Recommendation for economical sizes of natural draft chimneys based on draft and capacity requirements.

Concrete Design. Graphs for Design of Slabs and Beams, S. Cytryn. *Concrete & Constr. Eng.*, vol. 35, no. 2, Feb. 1940, pp. 77–87 and 98–99. Presentation of graphical charts and formulas for design of reinforced concrete slabs and beams; numerical examples.

Concrete Slabs. Face Forms Unnecessary with Pre-Cast Concrete Slabs. *Roads & Streets*,

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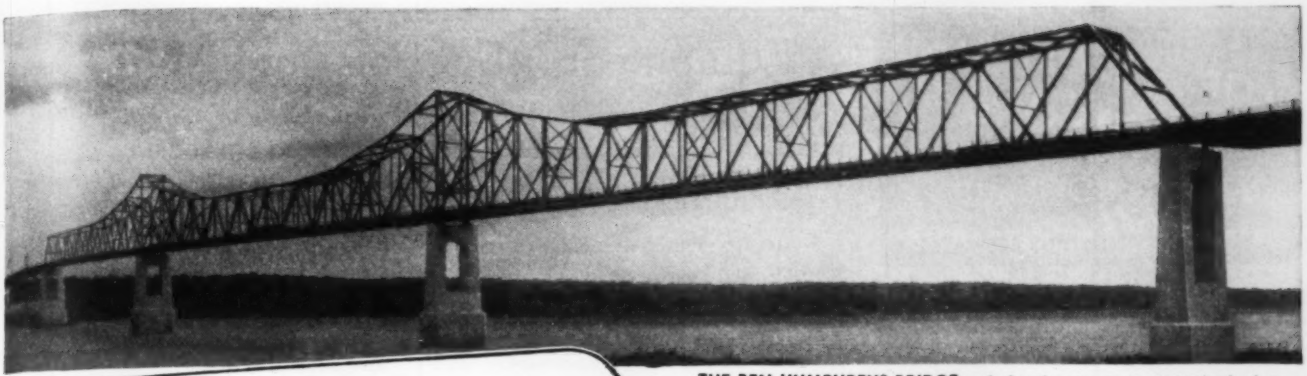
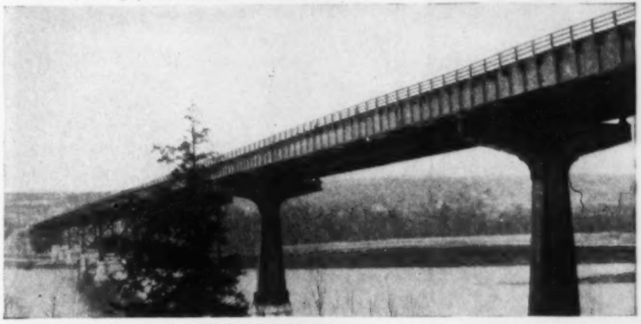


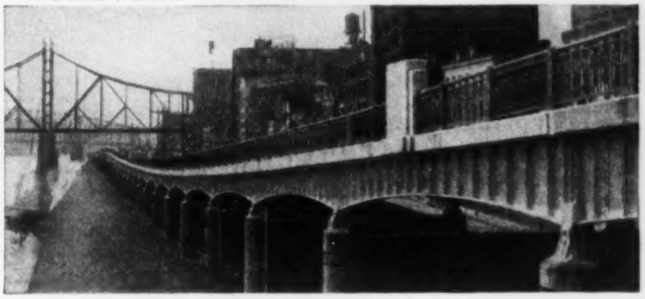
THE BEN HUMPHREYS BRIDGE. *A 2-mile structure, comprised of a 2121-foot cantilever crossing of the Mississippi River flanked by deck plate-girder approaches on curve and grade, carrying the 24-foot concrete roadway of U. S. Highway No. 82 between Greenville, Miss., and Lake Village, Arkansas.*

Notable structures in Steel mark 1940's highway development



WILBUR CROSS PARKWAY BRIDGE. *Typical of modern trend to continuous and cantilever plate-girder design, this 1284-foot bridge carries two 26-foot separated roadways of open-type I-Beam-Lok over the Housatonic River near Milford, Conn. Two unique T-type steel bents, anchored to single cylindrical piers, support the cantilever unit over the main channel.*

THE CENTENNIAL. *Distinctive as the first tied-arch river crossing of the Mississippi, the total length of this bridge, including deck plate-girder approaches, is 3851 feet. It carries two 22-foot separated concrete roadways which directly connect the business centers of Rock Island, Illinois, and Davenport, Iowa.*



WATER STREET PROJECT. *Part of the Water Street Reconstruction in Pittsburgh, Pa., for traffic segregation on paralleling roads, this 2300-foot viaduct skirts the Monongahela River and carries the 30-foot eastbound-traffic roadway. Supporting girders, of pleasing appearance, are combined cantilever and suspended units with curved bottom flanges.*

ENGINEERING skill achieved notable results in 1940 in the increasing development of the nation's highways. More than ever, the versatility and adaptability of steel construction was demonstrated as the solution for difficult problems in river crossings, elevated speedways, highway overpasses and ramps.

Steel construction, which has long since demonstrated its sturdiness and reliability, has met, too, the increasing challenge for impressive beauty. Countless graceful structures point to the fact that there is no need to sacrifice the aesthetic for strength. Steel has proved how efficiently and economically it can be engineered in harmony with its environment.

In this modern trend American Bridge Company has had the good fortune to play an increasingly important part. Doubtless we owe that to the long acquaintance engineers and contractors have had with our work on all types of steel structures, with our engineering personnel and facilities, our half century of experience.

While we have yet to find the fabrication and erection job too big or too difficult to undertake, we take particular pride in the fact that the smallest job, too, is given the full benefit of the best we have in skill and experience.

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Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

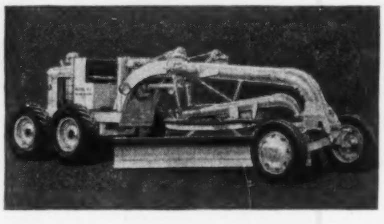
Giant Testing Machine

A 100-TON materials testing machine, which is reported to be so powerful that it can bend two parallel 12-in. steel I-beams, yet so accurately controlled that it can crack a nut without crushing the kernel, has been built by the Riehle Testing Machine Division, American Machine and Metals, Inc., of East Moline, Ill.

The dimensions of this machine indicate its size: 34 ft high, 21 ft wide, and $24^1/_2$ ft from front to back. The transverse table is 8 ft wide. Though this machine can exert a maximum of 700,000 lbs pressure, it is claimed to have recorded a maximum error of 0.06 of 1 per cent, making it an extremely sensitive machine. In routine tests the machine snapped 12 × 12 wooden timbers with a pressure of 500,000 lbs. Steel tubes 3 in. in diameter were crushed at 600,000 lbs pressure.

A-C Motor Grader

ALLIS-CHALMERS MANUFACTURING CO. announces the new Model "AD" Motor Grader. This machine, which weighs 21,500 lb and has 75 Diesel hp has been designed for heavy grading, bank cutting, ditching (both forward and reverse), oil mixing, and snow removal.



Greater earth-moving capacity is claimed because the 22 in. clearance under the "Hi-arch" front axle and $6^3/_4$ in. clearance of the circle permits the full volume of dirt to roll off the blade without hanging up in the axle or circle. Power is supplied by a General Motors 2-cycle Diesel engine. The transmission has a range of six forward and three reverse speeds, and with throttle control forward speeds from 1.48 to 16.6 miles per hr and reverse speeds from 1.75 to 6.15 miles per hr can be selected at will.

The full revolving blade has a bank cutting angle of 90° and has a blade reach outside the front wheels of 5 ft $7^1/_2$ in. The tandem drive assembly is supported on a $4^1/_2$ in. main drive shaft and is chain driven. Standard equipment includes electric starting and lighting, leaning wheel front axle, adjustable radiator shutters, muffler, 12-ft moldboard, two 7.50–24 (10 ply) front tires and four 12.75–24 (8 ply) rear tires. For special conditions 10 and 14 ft moldboards, 2 ft extensions, 11 tooth scarifiers, all steel canopy top or all steel cab and a V-type snow plow are available.

Wedge Gate Valves

A NEW AND COMPLETE LINE of standard iron body wedge gate valves for 125 lbs steam, 200 lbs cold working pressure has just been brought out by Crane Co. This new line includes both the brass trimmed and the all iron patterns with O.S. & Y., or non-rising stem, in sizes 2 to 12 in., inclusive. Also, the quick opening and the Underwriters' patterns, the alloy trimmed, alloy cast iron valves for process work, and the standard iron body valves for marine cargo oil systems. This complete line is illustrated and described in detail in a new booklet (No. A.D. 1452) which will be mailed on request to Crane Co. at 836 S. Michigan Ave., Chicago, Ill.

New Line of D-C Motors

COMPACTNESS and improved protection are two features claimed for the new d-c motors recently announced by General Electric Co., Schenectady, N.Y. A rolled-steel frame and improvements in end-shield and bearing-bracket construction combine to give the new motors protection from external damage. The use of Formex wire coils and Glyptal insulating varnish provide high resistance to impact, abrasion, and the action of foreign materials.

Open motors are available in constant-speed ratings from $^1/_2$ hp at 850 rpm up to and including 60 hp at 1750 rpm; and in adjustable-speed ratings from $^1/_2$ hp at 850/3400 rpm up to and including 15 hp at 500/1800 rpm. Motors in the larger ratings (beginning at 50 hp, 850 rpm) embody a new system of self-ventilation, extra protection of all current carrying and rotating parts, and large conduit boxes. The motors can be furnished with sleeve or ball bearings. Other features common to the entire line include lower WR^2; small diameter; reversal without changing any parts of the frame, fan, or brush rigging, and Textolite wedges in the armature slots to protect the windings.

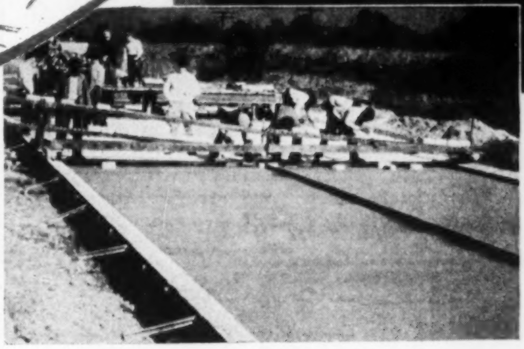
Earth-Moving Cost Calculators

TO ASSIST CONTRACTORS, engineers, and all interested earth-movers to rapidly compute probable production for cost estimates and analyses, the Field Engineering Department of R. G. LeTourneau, Inc., has prepared a handy, simple slide rule calculator.

While prepared primarily for LeTourneau tractor-drawn and Tournapull equipment, this instrument is useful in computing probable production of any earth-hauling equipment, over any grade or haul distance, and for average speeds as great as 40 mph. It may be secured free of charge by writing Field Engineers, R. G. LeTourneau, Inc., Peoria, Ill.

for Smooth rides...

BUILD A MODERN BRICK PAVEMENT



Not to be confused with standard two-course construction is this new and approved method for highway surfaces. You can now build brick roads with a perfect traffic surface at substantially lower cost! It is called vibrated monolithic brick... Vibrating machinery, recently developed, makes this possible.

In this method of construction (cut shows job under way in Jefferson County, Ohio) the brick are vibrated into the freshly placed concrete. Expansion and control joints are used. Grout filler completes the job.

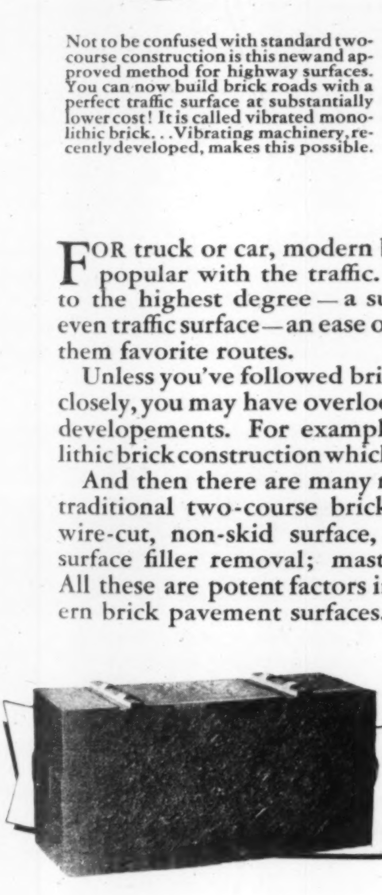
FOR truck or car, modern brick pavements are popular with the traffic. They give comfort to the highest degree — a superlatively smooth, even traffic surface — an ease of driving that makes them favorite routes.

Unless you've followed brick construction very closely, you may have overlooked important new developements. For example, Vibrated Monolithic brick construction which is illustrated above.

And then there are many new advances in the traditional two-course brick pavement such as wire-cut, non-skid surface, rolling on boards; surface filler removal; mastic bedding courses. All these are potent factors in ever-smooth modern brick pavement surfaces.

Hundreds of modern brick pavements have been built in the past few years. They are headed towards 50 years of trouble-free service. Like their predecessors, many of them will reach that anniversary — perhaps pass it! For of all commonly used paving materials, Vitrified Brick has by far the greatest resistance to weather damage — the starting point of most pavement failures.

Your community can use modern brick pavements to advantage. Put them wherever you want a road or street pavement to have the lowest cost per year of service. National Paving Brick Association, National Press Building, Washington, D. C.



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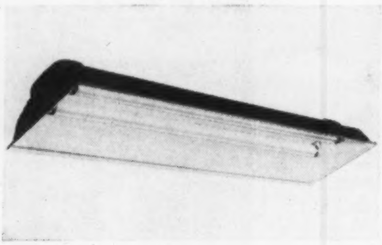
High Level Lighting

A NEW FLUORESCENT LUMINAIRE employing two of the recently announced 100 watt, 60 in. white, or daylight fluorescent lamps, and designed especially for general and supplementary high-level illumination in industrial or commercial areas is announced by the Westinghouse Electric and Manufacturing Co., Lighting Division, Edgewater Park, Cleveland, Ohio. The new 2-FPR-100 luminaires are available for operation on 110–125, 199–216, and 220–250 volts, 60 cycle AC.



Fixture consists of a hood, reflector, lamp holders, starting device, and ballast equipment. Access to line connections is easy as all auxiliary equipment is mounted and wired as part of the sheet steel hood assembly. Reflectors are 18 gage porcelain enameled steel. Two types are available: the direct which throws all light downward, and the diffuser type which allows a minimum of $2^1/_2\%$ upward light to pass through apertures above each lamp to reduce brightness contrast between the lighted area and the ceiling. Both reflectors provide a 14 degree shielding angle below the horizontal, when viewed normal to the lamps.

Units are arranged for rigid or flexible conduit, or chain suspension mounting. Levolier switches may be installed if desired. Standard units are shipped completely wired; and are finished with a smooth silver gray baked enamel.

Steel Railroad Tie

THE ANCHOR TIE for use in mine and industrial tracks, a new H-beam tie having only four loose parts, has recently been developed by Bethlehem Steel Company, Bethlehem, Penna. The gage of the track is definitely fixed by two double shouldered tie plates, arc welded to the 6 in. H-beam which is 8 ft long and weighs $15^1/_2$ lbs per ft. Four angles are arc welded directly beneath the tie plates between the two flanges of the beam, to act as stiffeners and retainers for the spring clamp. Due to the reinforcing effect of the welded tie plates and angles the completed tie is reported to have unusual strength for a light weight construction.

The rails are fastened to the ties by means of clamps of heat-treated, spring steel, four clamps for each tie. The clamps are driven and locked into place with a spike maul or sledge hammer. As the nose of the clamp bears against the base flange of the rail the loop produces a slight spring action which gives resiliency to the track structure. The Anchor tie has been tested for the last three years on a piece of industrial track where exceptional heavy service is encountered. A total of 400 ties were used in the test track.

Tunnel Ventilation Pipe

A STEEL VENTILATING PIPE for use in tunnel construction has been announced by Lock Joint Pipe Co. The features claimed for this pipe are: air tight self-centering joints; easy assembly and dismantling; made to fit job requirements; smooth interior and joint spaces reducing friction losses and pumping costs; and the ability to withstand negative as well as positive pressures.

Descriptions of its recent use and performance on large tunnel jobs and complete facts will be given by the Lock Joint Pipe Co., Ampere, N.J.

Printing Machine

MODEL "55" BW PRINTER, a 42-in. machine, announced by Charles Bruning Co., Inc., 100 Reade St., New York, N.Y., is quite compact, being 32 in. wide, 62 in. long, and 48 in. high.

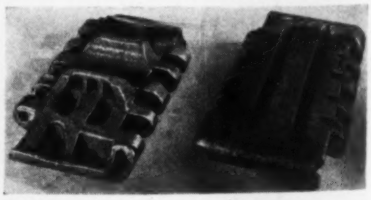
It operates with either cut sheets or roll stock, and prints ink tracings at from 12 to 15 ft per min. One of its features is the return of print and tracing in the same way as inserted in the machine, eliminating reversing of the tracing for reinsertion.

The light source of the new Model "55" Printer is a 55-watt new-type mercury vapor quartz lamp, guaranteed for a life of 1000 hours, and installed in a revolving 9-in. Pyrex contact cylinder. Other features are a double centrifugal blower to reduce operating noise; an automobile clutch, operated by a foot pedal, to release the feed roller so the tracing may be adjusted or removed; hinged sections to allow ready access to all electrical controls and drive mechanism; and an automatic switch to shut off the light when the end housing and cylinder are removed.

The "55" Printer is made for two currents—220 volts AC 60 cycles, or 220 volts AC 50 cycles. Operating electrical requirement for the machine is 3800 watts.

Manganese Steel for Tractor Shoes

A SHARP INCREASE in the use of manganese steel for tractor tread shoes for power shovels is reported by the Pettibone Mulliken Corp.



The company states that manganese steel is particularly suited for work under the severe operating conditions imposed on power shovels because it actually becomes tougher and more resistant to wear, abrasion, impact, and other stresses the longer it is used. Its acceptance by shovel men all over the country is typical of the many new applications industry is finding for this "toughest steel known."

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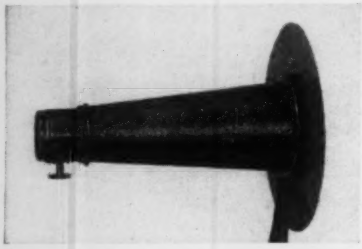

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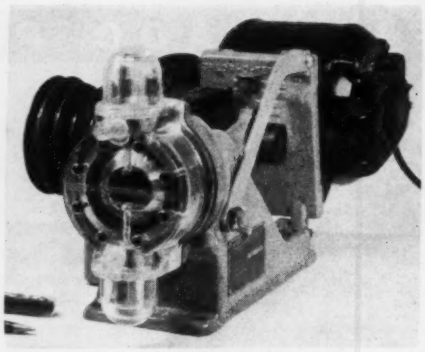

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Literature Available

AIRPLANE HANGAR CONSTRUCTION—The sixth edition of "Airplane Hangar Construction"—a 28-page booklet containing information and plans for the erection of wood hangars—has just been published by the National Lumber Manufacturers Association, 1337 Connecticut Ave., Washington, D.C. The booklet has been prepared primarily for the use of engineers, airport and aviation authorities.

ARC WELDING FOR BUILDING CONSTRUCTION—The 16-page folder published by Air Reduction, 60 East 42d St., New York, N.Y., will be of interest both from a design and a construction standpoint. The advantages of welding are illustrated specifically in a four-page magazine article reprint featuring the construction of the Airlines Terminals Building in New York City, which is followed by two pages of fundamentals of design for welded construction.

CONCRETE PUMP—"Why and Where to Pump Your Concrete with Pumpcrete" is a 24-page catalog of the 1941 Pumpcrete Models, the double cylinder models being equipped with the 3-way selective drive. Chain Belt Co., Milwaukee, Wis.

CONTROL INSTRUMENTS—"Instrumentation of a 'Typical' Modern Sewage Disposal Plant" is a 16-page bulletin, No. 232, published by Foxboro Co., Foxboro, Mass. Its title describes the contents.

EXCAVATOR—The P & H Model 955, available as a $2^1/_2$-yd shovel, a 3-yd dragline, a 3-yd clamshell, or a crawler crane, is described in the thirty pages of Bulletin X-21-1. Harnischfeger Corporation, Milwaukee, Wis.

GRIT COLLECTOR AND WASHER—The Link-Belt Straightline Grit Collector and Washer for collecting, washing, and removing settled grit from sewage, is illustrated and described in a 4-page folder, No. 1942. Link-Belt Company, Philadelphia, Penna.

PNEUMATIC TOOLS—Eight new tools are featured in the THOR No. 52 Pneumatic Tool Catalog, 1941 edition. Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. They consist of right angle and close corner drills, right angle nut setters and screw drivers, bolt wrenches, grinders, chipping hammers, sanders and saws.

SHOVEL—Bulletin X-71 covers the P&H 255-A excavator, its all-welded construction, three-speed transmission, and the patented P&H chain crowd. Harnischfeger Corporation, Milwaukee, Wis.

SMALL SHOVELS—With 67 photographic illustrations, bulletin No. 2066, just released by Bucyrus-Erie Co., South Milwaukee, Wis., tells the on-the-job story of ways in which contractors are making money with the versatile $^1/_2$ to $^3/_4$-yd shovels. Virtually every phase of excavating, grading, and dirt-moving operation is represented.

SWIM POOL PROTECTION—Bulletin FUN describes a new departure in fungicidal disease control in foot-baths combined with regular pool purification. Proportioneers, Inc., 14 Codding St., Providence, R.I.